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Introducing calculators in year one mathematics : Attitudes and achievement

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**INTRODUCING CALCULATORS IN YEAR ONE MATHEMATICS:
ATTITUDES AND ACHIEVEMENTS**

BY

VANESSA THORPE B.A. (Ed.)

A Thesis Submitted in Partial Fulfilment of the Requirements

For the Award of

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At the Faculty of Education

Edith Cowan University

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USE OF THESIS

The Use of Thesis statement is not included in this version of the thesis.

ABSTRACT

This study investigated the attitudes and achievements of year one students using calculators to facilitate their pattern development. The investigation also involved the attitudes of the classroom teacher and parents to the use of calculators in mathematics education for year one students.

A class of 22 year one students (10 males and 12 females) was chosen for the study. The class was involved in one forty-minute lesson per week using calculators for ten weeks. The lessons focused on the topic of patterns. The calculators were also available for the children to use in their free time.

The effects on student performance were evaluated based on pre- and posttests. Changes in student attitudes were evaluated based on questionnaires given before and after the study, observations recorded in a researcher journal, and interviews with six selected students. Change in the teacher's attitude to using calculators was investigated using interviews before and after the study. Parent attitudes were evaluated using a questionnaire form at the completion of the instructional phase of the study.

It was concluded that student performance had improved after the study, with students more able to correctly identify, continue and make up their own patterns. Student attitudes were also improved, with the calculators acting as a motivating tool for the students. The classroom teacher

became much more positive and enthusiastic about the use of calculators with young children after she had observed her class using calculators. The investigation also revealed that parents do not receive much information about using calculators with young children, but would like more information about this topic. At present, however, the parents feel that there could be detrimental effects from using calculators before students have mastered number work using traditional paper and pencil methods.

DECLARATION

I certify that this project does not, to the best of my knowledge and belief:

- (i) incorporate without acknowledgement any material previously submitted for a degree or diploma in any institution of higher education;
- (ii) contain any material previously published or written by another person except where due reference is made in the text; or
- (iii) contain any defamatory material.

ACKNOWLEDGEMENTS

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Thankyou also to the school which participated in this study, and in particular the teacher who let me use her class to carry out the investigation. Her generosity, patience and support enabled me to carry out my study in a welcoming environment.

Lastly, thankyou to my family, who will be delighted to see this thesis finished.

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CHAPTER I

INTRODUCTION

Background to the Study

Calculator use in mathematics has been advocated since the late 1970s but teachers and parents have been slow in accepting the calculator as a viable teaching tool (Sparrow, Kershaw & Jones, 1994). State, national and overseas curriculum documents have stated for some time the importance of using calculators at all year levels. The *Learning mathematics handbook* (Ministry of Education, 1989) states that calculators will soon remove the need for more complex paper and pencil algorithms. *A National statement on mathematics for Australian schools* (Australian Education Council, 1990) and *Mathematics Counts* (Cockcroft, 1982) both emphasize the need to use calculators at all year levels of education.

Research shows, however, that there is a strong resistance to the use of calculators from many teachers and parents (Sparrow, Kershaw & Jones, 1994). This is despite the fact that studies show there are no detrimental effects from using calculators as a teaching tool (Stacey & Groves, 1996). Thus, even though it has been recognized amongst mathematics educators that calculators have the potential to significantly change what is learnt in mathematics and how it is learnt, there has been no universal move to adopt calculators into the classrooms.

Significance of the Study

Results from this study should add to the increasing body of research which has focused on using calculators in school. Various documents (as outlined in the literature review) support the use of calculators in the mathematics classroom, yet it does not appear that calculators are being integrated into the classroom in the way that has been advocated (Stacey & Groves, 1996). The results from this study will add further data concerning the benefits and/or disadvantages of using calculators with year one children.

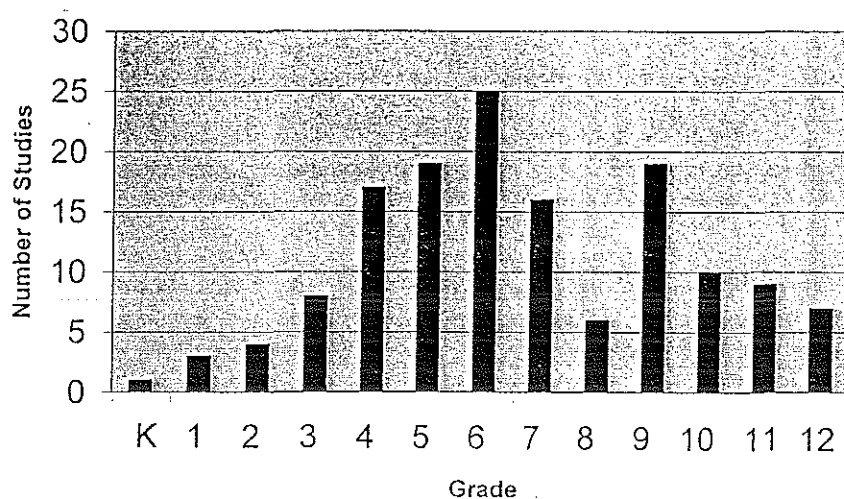
This study concerns attitudes and achievements in order to get an overall view of how calculators can affect education. The attitudes students have regarding mathematics is crucial to consider, as this will affect their mathematical performance (Ministry of Education, 1989; Australian Education Council, 1990). The actual achievements of the students is also vital, because if the students do not gain the necessary concepts and skills when using calculators the lessons have not been successful. The attitudes of the teacher and parents also need to be considered, as these will have an effect on the way the students perceive the exercise, thereby influencing the students' performance (Australian Education Council, 1990).

This research will also provide data regarding the value of the use of calculators with young children. There is little research that has specifically focused on calculators with young students. Suydam (1982) found only

eight out of 75 studies on calculator use in the classroom were conducted with pre-primary to year two students (see Figure 1).

Figure 1.

Suydam's Comparisons of Grade Levels in 75 Studies of Calculator Use.



Although calculator use has been studied to a limited degree with year one students there do not appear to be any studies focusing on the effect calculator use has on pattern development, which was the focus of this study. It is necessary to see how calculator use affects particular aspects of children's mathematical development in order to get an overall view of the benefits and disadvantages of using calculators. Thus, this study appears to be unique in its focus on number patterns.

Purpose of the Study

The purpose of this study was to investigate the effects calculators have on student performance and attitude of year one children. The study also

investigated changes in teacher attitude after observing children using calculators, and parent attitudes towards calculator use with year one students.

Both teacher and parent attitudes will have an influence on student learning, as will the attitude the students themselves hold, so it is necessary to understand the attitudes of these people if we are to ensure students are able to learn to their full potential. Calculators are a relatively new introduction into schools, so it is important to study their effects on all people involved in a child's education.

Research Questions

This research was aimed at answering the following questions:

1. In what ways does the use of calculators affect Year One students' understanding of patterns?
2. In what ways do the attitudes of Year One students to mathematics in general, and the use of calculators in particular, change after using calculators?
3. How does the attitude of a classroom teacher change when she has observed Year One students using calculators?
4. How do the parents of Year One students feel about their children using calculators in mathematics?

CHAPTER II

LITERATURE REVIEW

This literature review will focus on information relating to constructivism in the classroom, background literature on calculators, the role of calculators in the classroom, and teacher and parent attitudes regarding calculators in the classroom. Calculators and student attitudes will also be discussed, as will studies incorporating calculators in the classroom, pattern development and calculators, and literature on methodology.

Constructivism in the Classroom

'To promote meaningful learning, teachers must know how to tailor instruction so that it meshes with children's thinking' (Baroody & Ginsburg, 1990, p. 51). This highlights the importance of teaching to suit the learning styles of the children. A constructivist manner of teaching will best cater to children's learning styles, as it is generally agreed (Malone & Ireland, 1996) that children learn by constructing their own meanings.

Although there are numerous interpretations of the word constructivism, one common characteristic runs through all definitions.

It is assumed that learners have to construct their own knowledge – individually and collectively. Each learner has a tool kit of conceptions and skills with which he or she must construct knowledge to solve problems presented by the environment. The role of the community – other learners and

teacher – is to provide the setting, pose the challenges, and offer the support that will encourage mathematical construction (Davis, Maher & Noddings, 1990, p. 3).

Children are informally involved in mathematics long before they enter school (Baroody & Ginsburg, 1990). This informal mathematics involves children actively constructing knowledge, rather than just absorbing passively what is said to them. Such informal mathematics is 'natural' to children as they construct their own understandings, and this is the environment that we must continue to foster for children at school if they are to realize their full potential (Baroody & Ginsburg, 1990).

The National Curriculum Council's *Non-Statutory Guidance* (1989, as cited in Sugarman, 1992) states 'in order to progress through the levels, pupils at every stage should be encouraged and helped to develop *their own* methods for doing calculations' (p. 46). This statement is consistent with constructivist beliefs. Constructivism also requires exploration to create understanding, and the calculator is well suited for exploring and stimulating thought.

The key to exploration in the classroom is finding the necessary time. And time is exactly what can be saved by using calculators – time for searching, conjecturing, and testing – in short, time for thinking. If calculators are used to explore and to encourage thought, then and only then should calculators be required in mathematics classrooms (Higgins, 1990, p. 5).

Constructivism is an important aspect of the classroom environment in order for children to gain an understanding that is meaningful to them. The following quote by Swan & Sparrow illustrates the significance of constructivism:

At the heart of constructivism is the notion that everyone is different and hence will construct or build knowledge in different ways based on previous experiences and the current learning situation. Mathematics educators, therefore, should be trying to encourage students to become mathematical thinkers rather than to follow blindly a set of transmitted procedures learned in a rote fashion (1997, p. 140).

Using calculators provides another tool for students to use to construct their own understandings, and so will further aid their mathematical education.

Background Literature on Calculators

'Few issues have caused as much debate in mathematics education as the argument of whether calculators should be used in the primary classroom' (Swan & Sparrow, 1997, p. 136). Calculators have now been available for over twenty years and yet this debate about their use in primary schools continues.

When the education community first had access to pocket calculators they were greeted with overall enthusiasm by academics, suspicion by teachers and strong negative feelings by parents (Swan & Sparrow, 1997). It is now

widely recognized that calculators have the potential to 'transform school mathematics from a procedurally dominated subject to the exciting study of patterns and relationships' (Wheatley & Shumway, 1992, p. 1).

Mathematics counts (Cockcroft, 1982) was one of the first major reports to advocate the use of calculators in the classroom. The report claims that 'from all the studies the weight of evidence is strong that the use of calculators has not produced any adverse effect on basic computational abilities' (Cockcroft, 1982, p. 110). The report also notes that there is 'little doubt of the motivating effect which calculators have for very many children, even at an early age' (Cockcroft, 1982, p. 110). If calculators are shown not to have any adverse effects, but can produce the motivation for students to learn, it seems reasonable to conclude that calculators will benefit students' mathematical learning.

A National statement on mathematics for Australian schools (Australian Education Council, 1990) also advocates the use of calculators in classrooms. The statement recommends that 'as far as resources allow, teachers should ensure that all students use calculators at all year levels (K-12)' (Australian Education Council, 1990, p. 23). The statement recognized the ability of calculators to 'provide students with opportunities to investigate certain mathematical ideas and applications at a younger age than they might otherwise have done' (Australian Education Council, 1990, p. 14).

However, there has been no universal move towards the use of calculators in primary schools despite the support they receive from official documents

(Stacey & Groves, 1996), although 'every professional organisation interested in improving school mathematics programs now advocates the use of calculators in instruction' (Chambers, 1989, p. 10)

When considering incorporating calculators into the classroom it is important to understand why this is necessary.

For well over a decade, calculators have been recognized as having the potential to profoundly change the curriculum and the nature of mathematics teaching, with widespread agreement amongst mathematics educators in many countries that calculators should be integrated into the core mathematics curriculum (Stacey & Groves, 1996, p. 205).

Many researchers believe that using calculators in mathematics will aid children in developing problem solving strategies by removing the focus from computation, therefore allowing children to focus on the process involved. This will enable the children to develop a broader range of strategies (Suydam, 1982). It is also believed that 'calculators can play an important role in students' construction of mathematical relationships' as well as 'students' construction of number patterns that form the basis of mathematical reasoning' (Wheatley, Clements & Battista, 1990, p. 23).

Such research as shown here advocates the use of calculators as an important instructional tool which increases students' learning. However, the calculator will not perform miracles by itself. 'The calculator is not a replacement for the teacher nor for teaching. It does not replace the need

to relate mathematical concepts to concrete models' (Watson & Trowell, 1988, p. 53). Calculators do, however, provide teachers 'with a window into children's thinking about the mathematics they are doing' (Stacey & Groves, 1996, p. 223). Suydam (1982) describes calculators as 'simply too handy a tool to ignore' (p. 1). However, not everyone supports this view. Costello (1992) states: 'Calculators have made remarkably little impact on school mathematics. This is in spite of long-predicted radical effects' (p. 21). Costello's view is in contrast to the majority of researchers, who believe the real issue is 'not *whether* calculators should be used in mathematics classrooms; it is *how* calculators should be used in classrooms' (Higgins, 1990, p. 4).

The Role of Calculators in the Classroom

Calculators can be used in a variety of ways in the classroom. The *WA Learning mathematics handbook* (Ministry of Education, 1989, p. 30) recognizes that calculators can be used as an instructional aid to 'assist in the development of mathematical content ideas . . . (such as) place value, multiplication as repeated addition, and the learning of basic facts', and as a computational aid to help children 'perform many needed calculations quickly and accurately, particularly to encourage the use of many strategies in solving problems'.

Calculators can be used:

- As a recording device;
- A counting device;

- To explore number patterns;
- To discover relationships and to develop concepts that may be obscured by tedious or difficult computations;
- To practice mental estimation;
- To reinforce the inverse relationships of operations and provide readiness work for equation solving;
- In application problems;
- To develop problem solving techniques; and
- For individual exploration and enrichment.

(Adapted from Stacey & Groves, 1996; and Morris, 1978).

Calculators must be used in creative ways for students to get the most benefit from the experiences. Teachers must provide activities that are more than just 'token' calculator activities, that is, those which only require the use of the calculator because the teacher has been told to use calculators. If this is the case the children will learn very little. 'Simply keying a problem from a mathematics textbook into a calculator and pressing the equals key may very well be a way to avoid thinking. Teachers who cannot imagine any other ways to use calculators in classrooms should be required to stop using calculators in mathematics classrooms at once!' (Higgins, 1990, p. 4). There are many creative uses for the calculator, as described above. They should not be used as a way of getting out of difficult work. Higgins (1990) describes it best: 'If calculators are used as a substitute for thinking, of course they rot the mind!' (p. 4). Rather, the activities should be catered to fit the children's

needs to enhance their mathematical development. This will not, however, disrupt the whole curriculum. 'Calculator activities that require problem-solving skills, that use the calculator as a tool to avoid "getting bogged down" in tedious computation, and that stimulate the imagination and interest of students, are valuable and compatible with existing programs' (Morris, 1978, p. 24).

Teacher and Parent Attitudes to Calculators in Schools

Suydam (1982) looked at 75 studies relating to calculator use in schools. Twenty-seven of these studies investigated the attitudes of parents and teachers to calculators. Suydam reported that the acceptance of calculators in classrooms had increased in 1982 compared to 1976, in regard to both teachers and parents. The findings also indicate that the level of acceptance increases as the grade level of the children increases. However, although using calculators in schools was being more readily accepted in 1982, they still were not commonly used in many classrooms.

In 1990 another study was conducted with 700 teachers from 100 Melbourne schools, investigating teachers' attitudes towards calculator use and the extent and purpose of calculator use in their classrooms. The findings of this study showed that '75% of teachers supported calculator use in Kindergarten to Grade 3, compared with a mere 7% in 1980. These attitudes, however, did not necessarily translate into practice. In the 1990 sample, 58% of K-3 teachers admitted to rarely or never using calculators in their classrooms' (Stacey & Groves, 1996, p. 208).

Sparrow & Swan (1997) completed a more recent survey involving 787 teachers in Western Australia, from both state and independent schools. The survey found that many teachers viewed a calculator in a restricted way; viewing it primarily as a machine to do computations. The idea that it may be used as a teaching and learning tool was uncommon. Rather, teachers tended to consider calculators as an extra to the normal curriculum. This also raised the issue of time availability. Teachers consider they already have too much to teach, and no more can be fitted in. The survey also found that textbook materials had a strong influence on calculator use. If the text did not specify the use of calculators the teachers didn't include them. Sparrow and Swan state:

There seems to be no planned use of calculators in the programs of many teachers. If calculators are used it is for trivial, incidental or "fun" activities. The impression given is that the calculator is not important and that using it is tantamount to cheating (Sparrow & Swan, 1997).

Although these studies show that calculators are increasingly being accepted into classrooms, many teachers and parents are still opposed to such a change. It is important to consider why many teachers and parents are still opposed to implementing calculator use if we are to convince them of the benefits calculators will bring. It has been found that the reasons teachers have for not utilizing calculators include:

- Teachers are far from convinced that calculators do enhance understanding;

- Many teachers have a lack of confidence and knowledge about ways of using calculators;
- Teachers may not be aware of the research regarding calculators;
- Confusion about the research or ambiguous findings cause teachers to dismiss the idea;
- Using a calculator makes children lazy – you don't need to think when you use a calculator;
- Children who use calculators may not be able to carry out the traditional pencil-and-paper algorithms for the four rules, so they won't understand how numbers work;
- The need to teach 'the basics' first; and
- The danger of children becoming over-dependent on them.

(Adapted from Warren & Ling, 1995, Shuard, 1992b, and Hembree & Dessart, 1986).

These concerns of teachers and parents must be addressed. Obviously teachers need to be made aware of the benefits of using calculators. In-service training focusing on why and how calculators should be used would encourage many more teachers to use them, as they will understand why they should be used and how they can use them effectively. Warren & Ling's (1995) study showed that the majority of teachers were keen to 'increase their knowledge about ways of using calculators effectively' (p. 24). Suydam (1982) found that 'teachers' attitudes became increasingly positive after workshop or other in-service work' (p. 5). Educating student teachers about using calculators in schools

will ensure that when they become qualified they will be much more enthusiastic to use calculators as they know how and why to use them. 'Student teachers' views about calculators, determined by their experience as pupils in schools must be examined and challenged . . . Above all students need to try out activities with children and see the benefits for themselves' (Warren & Ling, 1995, p. 24).

When teachers complain of the lack of availability of calculators in schools it is important to put this comment into perspective. The majority of classrooms now have computers installed, but a class set of calculators would be much less expensive. 'Any lack of availability of calculators in K-3 classrooms must reflect the priority attached to their use, rather than their cost' (Stacey & Groves, 1996, p. 208).

The question of the role of formal paper and pencil algorithms and the balance of emphasis placed on mental, paper and pencil and calculator computations is of crucial importance in mathematics teaching at this time. Of the three available methods of computation, mental and calculator computations are the ones typically used in everyday life. However, paper and pencil methods still receive the most emphasis in schools. The emergence of calculators and computers serves to highlight the lack of congruence between school mathematics and real mathematics (Willis & Kissane, 1989, as cited in Swan & Sparrow, 1997, p. 141).

All three methods of computation (mental, calculator and pencil and paper) are important skills children should master, but we need to 'teach the students when mental arithmetic and pencil-and-paper calculations have an advantage over calculators' (Higgins, 1990, p. 5), and vice versa. It is important to remember that 'two-thirds of all elementary school mathematics is taught in order to make calculators and micro-processors obsolete' (Chambers, 1989, p. 10). However, since calculators are frequently used in real world mathematics we must decrease the emphasis on relatively unimportant mathematics, that which is made insignificant by calculators (Chambers, 1989).

Another important point to remember is that 'algorithms do not necessarily achieve what is claimed for them and that, despite their undoubted usefulness to a pre-technology society, they must now give way to newer priorities in the face of changed circumstances' (Duffin, 1991, p. 42). Many teachers and parents argue that children should first learn traditional paper-and-pencil methods before using calculators, but, as Duffin so accurately puts it, 'should we learn how to shoe a horse before driving a car?' (1991, p. 42).

Even though many parents had feelings of failure and inadequacy when they were learning mathematics they still expect their children to learn in the same manner they did (Taylor & Thompson, 1992, p. 42). What hope do we have if teachers and parents refuse to keep up with technology, despite the fact that the majority of them use this very technology frequently?

It is also important to remember most people who argue against calculator use in schools 'have not had the opportunity to observe, in primary classrooms, how children can use calculators to enrich, widen and develop their mathematics' (Shuard, 1992b, p. 37).

Calculators and Student Attitudes

The attitude students have about what they are engaged in will determine the amount of attention they give and therefore the amount they will learn. Wheatley & Shumway (1992) believe that calculators will ensure that mathematics becomes more exciting for students as attention will be focussed on meaning. Wheatley & Shumway are not the only researchers to advocate the motivation calculators cause. Standifer & Maples (1981) describe calculators as 'intrinsically reinforcing' (p. 17) as the students receive immediate verification of responses, which is an important factor in learning. However, one of the best ways to describe the motivation calculators bring to students is by looking at an example where they have been used in an activity.

A few days ago my students were learning to use the calculator to count by 2s, 5s and 10s. During the middle of my lesson, the bell sounded for a fire drill. My students were having so much fun that they did not want to leave the room. I told them that everyone must clear the building. They did . . . carrying their calculators with them (Watson & Trowell, 1988, p. 50).

Studies Incorporating Calculators in the Classroom

Meta-analyses

Suydam (1982) summarized research findings on calculator uses which seem applicable to instruction from the period 1978–1981. This summary related to seventy-five studies, but very few of these studies related to junior primary students. Only three out of the seventy-five studies were concerned with year one students (see Figure 1).

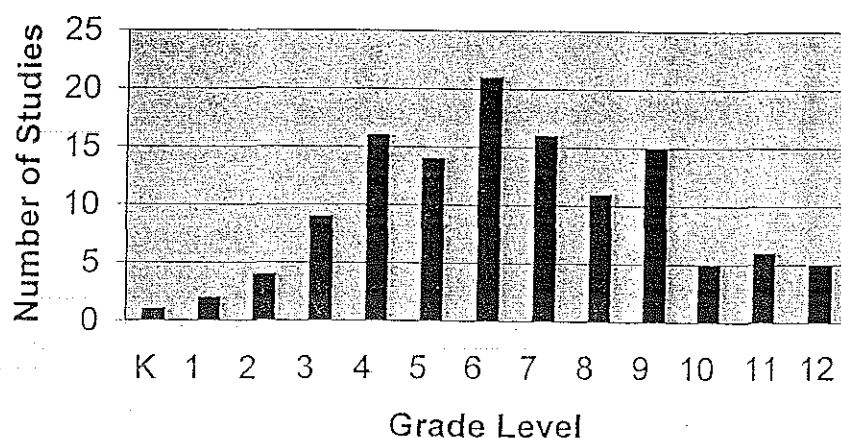
The findings of this summary of research showed 19 percent of the studies reported mixed findings (some supporting and some not supporting the use of calculators). Over one third (35 percent) of the studies provide evidence that students score higher when calculators are used, 44 percent indicate there are no significant differences, and only three percent report that using calculators resulted in lower scores than using paper and pencil. 'Thus, the evidence clearly supports the idea that use of calculators will result in achievement as high or higher than when calculators are not used. The number of studies in which calculators use is not as effective is miniscule in comparison' (Suydam, 1982, p. 2).

However, we are not told in this summary how the lessons were conducted or whether any other variables could have contributed to the outcomes. This could have had an impact on the findings so we can not conclusively say from these findings that using calculators will give just as good, if not better, results.

Hembree & Dessart (1986) conducted a meta-analysis to assess the effects of calculators on student achievement and attitude. All year levels were represented in the meta-analysis, but the distribution of studies across the year levels was uneven, with only two out of a total of seventy-nine studies dealing with year one students (see Figure 2).

Figure 2.

Distribution of Grade Levels in 79 Studies of Calculator Use.



Conclusions from the findings of the meta-analysis were generalized as follows:

1. In Grades K-12 (except Grade 4), students who use calculators in concert with traditional instruction maintain their paper-and-pencil skills without apparent harm. Indeed, a use of calculators can *improve* the average student's basic skills with paper and pencil, both in basic operations and in problem solving.
2. Sustained calculator use by average students in Grade 4 appears counterproductive with regard to basic skills.

3. The use of calculators in testing produces much higher achievement scores than paper-and-pencil efforts, both in basic operations and in problem solving. This statement applies across all grades and ability levels. In particular, it applies for low- and high-ability students in problem solving. The overall better performance in problem solving appears to be a result of improved computation and process selection.
4. Students using calculators possess a better attitude toward mathematics and an especially better self-concept in mathematics than noncalculator students. This statement applies across all grades and ability levels.
5. Studies with special curricula indicate that materials and methods can be developed for enhancing student achievement through instruction oriented toward the calculator. However, such special instruction has been relatively unexamined by research.

(Hembree & Dessart, 1986, p. 96)

Hembree and Dessart conducted another meta-analysis in 1992. The aim of this was to add to the first study, involving a further nine additional studies that probed effects of calculator use in precollege mathematics. The results from this study showed the same findings as the previous study.

Although Hembree and Dessart claim to have 'exhaustively' (1986, p. 96) collected data to provide representative results, not all people would agree that these results are valid. Goldin (1992) claims that many variables are ignored in meta-analyses, which impedes progress in understanding what

is happening so future research can be based on it. When describing the meta-analysis technique, Goldin states it 'dilutes the most salient empirical data, omits the variables that do not readily accommodate the statistical technique, and disregards the most fundamental insights obtained through research in the field' (1992, p. 274). However, Goldin does concede that 'meta-analysis can in fact provide answers to certain kinds of carefully formulated questions, when great caution is exercised' (1992, p. 274).

Calculators and Student Achievement

Standifer and Maples (1981) conducted a study involving nine classes. The classes were randomly split into three groups, each containing three classes. All nine classes were randomly selected third-grade classes in Monroe, Louisiana. One group became the control group of the study (N = 64), one was the group using hand held calculators (N = 77), and the final group used programmed-feedback calculators (N = 82). Pretests, posttests and retention tests were used to evaluate the effects of hand-held and program-feedback calculators on student achievement. The findings of this study are listed below:

1. The hand-held calculator group was superior to the program-feedback calculator group in computational skill.
2. The program-feedback calculator group was superior to the control group in computational skill.
3. The hand-held calculator group was superior to both the program-feedback calculator group and the control group in total mathematical achievement.

4. In computational skill, retention test scores of the hand-held calculator group were superior to both other groups.
5. In total mathematical achievement, retention test scores of the hand-held calculator group was superior to the other groups.

(Standifer & Maples, 1981)

Although this study shows overwhelming support for the use of calculators, especially hand-held calculators, with third-grade students, there are some criticisms of the techniques used. The two groups using calculators were only using the calculators for eight to ten minutes per day. At other times they were using normal paper-and-pencil methods. This doesn't really constitute integration. Also, the two groups were mainly using the calculators for checking results of paper and pencil computations, to drill the basic facts, and to perform calculator activities provided by the investigators. There is no information as to what these activities were. It is possible that it was the lessons themselves, rather than actually using the calculators, that produced the desired results.

Leechford & Rice (1982) researched the effect of a calculator-based curriculum on sixth-grade students' achievement in mathematics. The study involved 16 boys and 17 girls in a randomly selected sixth-grade class. A pretest and posttest was used to determine differences in student achievement. The class was split in two groups, one of which used calculators on the posttest, while the other did not. The findings of the study are as follows:

1. A specially adapted calculator-based curriculum had an effect on subjects' achievement in computation.
 2. This calculator-based curriculum had an effect on students' achievement in problem solving.
 3. There is no significant difference between performance of males and females on either the pretest or posttest.
 4. A calculator-based curriculum did not adversely effect the achievement level of subjects who did not use calculators during the posttest.
- (Leechford & Rice, 1982)

There are, however, a few problems with this study. The authors fail to include enough relevant information about the study for the reader to fully understand what was involved in the study. They do not include the time span the study was conducted over, nor information about the types of problems that were solved by paper and pencil methods, mental estimation and calculator manipulation. The aim of the study was to investigate the effect of a calculator-based curriculum on students, yet the authors do not describe the curriculum, so the reader does not know what happened. Another flaw is that the authors concluded their curriculum was beneficial because the posttest scores were significantly different from the pretest scores. However, the students had also been subject to instruction on problem solving, so this may have had an impact on the posttest scores, rather than using the calculators. The reader is not given enough information to conclude that the difference in pre- and posttest scores is due to the effects of calculator use rather than another variable.

Student Attitudes

Suydam's (1982) summary of research (described above) also included studies investigating student attitude to mathematics. Thirty-six studies were found in which the attitudes of groups using and not using calculators were compared. Of these thirty-six, thirty reported no significant differences between the groups, and the other six studies reported that attitudes improved when calculators were used. This is quite surprising when 'many teachers report that the use of calculators is motivating for children' (Suydam, 1982, p. 5). 'The relatively short period of time in which many studies took place is certainly one factor which accounts for the lack of change in attitudes, combined with the lack of sensitivity of the instruments used to assess attitudes' (Suydam, 1982, p. 4). This data suggests that using calculators is at least as motivational for students as not using calculators.

Suydam (1982) reported that 'no evidence was found that elementary school students become calculator-dependent' (p. 4). It appears that the students only used the calculators when they were convenient, and did not use them if there was no particular advantage to it. 'However, students were less afraid to attempt difficult problems when they could use calculators' (Suydam, 1982, p. 4). This is an important point, because if students feel pressure on them it may affect their performance.

Calculator-Aware Number Curriculum Project

The Calculator-Aware Number Curriculum (CAN) project was a four year study investigating the effect of complete acceptance of calculators in the

primary classroom over a long period of time. The study was conducted in England and Wales, and represented a combination of large and small schools, in various environments (town, country and suburban). The study started in 1986, incorporating nearly 800 six- and seven-year-old children and their teachers. Each year the new six- and seven-year-old children in the schools involved joined the CAN project. The study was based on the philosophy that most people perform everyday calculations either mentally or with the use of a calculator if the numbers are too large or inconvenient. The students involved in the study had calculators freely available to them and could use these, or other methods, to solve the problems they were presented with.

It was decided the project would be evaluated qualitatively because 'it would be difficult to make valid numerical comparisons between project children and control groups of children in other schools' (Shuard, Walsh, Goodwin & Worcester, 1991, p. 55). Thus, the evaluators observed and reported on the activities of teachers and children, and had to try to evaluate the quality of the observed changes.

'Many of the children who have been working on the CAN curriculum for the past year have exhibited a changed perspective about mathematics' (PrIME Project, 1987, p. 23). This was attributed to various reasons, such as 'the children have control over their own work, their own methods are valued and discussed, and every child can achieve some degree of success'. The teachers, in general, found that the children's confidence and enthusiasm increased after being part of the project for one year.

Teachers and head teachers involved in the project made some important comments. These include: 'some children initially resisted all this thinking and only wanted an answer. Now they won't accept only an answer; they demand an explanation' and 'we used to struggle with apparatus to teach them to add in tens and units. Now they do it easily with their calculators' (PrIME Project, 1987, p. 27). Overall, the CAN Project produced some useful findings about the benefits of using calculators in junior primary mathematics programs. *CAN in Suffolk* (Rowland, 1987, p. 16) identified the following from observing CAN classrooms in Suffolk after the first six months:

1. Children exposed to a calculator-aware curriculum tend to develop a precocious familiarity with "large" numbers.
2. Likewise, I saw evidence of the development of impressive and efficient mental methods for calculation, particularly with whole numbers less than 100.
3. So-called keyboard skills with a calculator seemed to come easily and naturally to most children without explicit instruction from the teacher.

This indicates that after only six months of having access to calculators in mathematics classroom the students were showing improvements. Thus, even after using calculators for a short period, students can gain many benefits from the experience.

Calculators in Primary Mathematics Project

Another study similar to the CAN Project was one undertaken in Victoria, Australia. The *Calculators in Primary Mathematics* project investigated the effects of the introduction of calculators on the learning and teaching of primary mathematics over four years. The project commenced at Kindergarten and Grade 1 in six schools in 1990, and moved up to Grade 4 children by 1993. Over the four years 79 teachers and approximately 1000 children participated in the project, approximately half of whom participated for the full four years. All students had access to their own calculator in class. A group of children who had not been part of the calculator project and were assumed to have minimal exposure to calculators formed the control group for the study. The teachers were not given prescribed activities they had to use, but were allowed to investigate ways the calculator could be incorporated into classroom use. Members of the project team regularly provided the teachers with feedback and support. The findings from this study showed:

An analysis of the Grade 3 and 4 interviews showed that children with long-term experience of calculators performed better than children without such experience on a range of computation and estimation tasks and some "real world" problems; exhibited better knowledge of number, particularly place value, decimals and negative numbers; made more appropriate choices of calculating device; and were better able to interpret their answers when using calculators, especially

where knowledge of decimal notation or large numbers was required. Written testing, with and without calculators, confirmed that these children had better understanding of the number system and were somewhat more able to identify an appropriate operation in a work problem. No detrimental effects of calculator use were detected (Stacey & Groves, 1996, p. 207).

Figure 3 shows the percentages of children in the study that were able to correctly read given numbers at different grade levels after using calculators.

Figure 3.

Percentages of Children Able to Correctly Read Given Numbers at Different Grade Levels

Kindergarten (n = 29)	Number	74	126	203	
	% correct	46	7	4	
Grade 1 (n = 24)	Number	203	1435	62 750	1 000 000
	% correct	58	46	21	12
Grade 2 (n = 23)	Number	87	372	3294	5.7
	% correct	100	100	65	39

- Shaded table cells indicate numbers beyond the normal curriculum.

From all these studies it appears that 'the wide range of skills and understandings present in any classroom appears to be highlighted by the presence of the calculator' (Stacey & Groves, 1996, p. 220).

Although calculator use has been studied with year one children there do not appear to be any studies focusing on the effect calculator use has on

pattern development, which was the focus in my study. It is necessary to see how calculator use effects all aspects of children's mathematical development in order to gain an overall view of the benefits and disadvantages of using calculators.

Pattern Development and Calculators

'Mathematics is a study of patterns and relationships' (Reys, Suydam & Lindquist, 1989, p. 2). This quote illustrates the important aspect of patterns. Not only are patterns used in mathematics, they can be found in other curriculum domains, such as music, nature and art. 'Exploring patterns helps students develop mathematical power and instills in them an appreciation for the beauty of mathematics' (NCTM, 1989, as cited in Coburn, 1993, p. 1). Studying patterns encourages children to make connections between mathematics and other disciplines (Coburn, 1993). 'In the process, mathematics is both motivated and described by patterns' (Coburn, 1993, p. 1). This shows how important patterns are in mathematical development.

Calculators can be used to explore patterns in a number of ways. They can be used to record patterns, transfer patterns from one medium to another, or for children to explore and create their own patterns. Using calculators to explore patterns provides the opportunity for children to construct their own understandings about patterns and gain a better understanding of how mathematics works.

Literature on Methodology

The traditional scientific approach 'has been the conventional approach to research in all areas of investigation' (Burns, 1990, p. 3). Quantitative approaches are usually designed to generate and test ideas, so hypotheses are formulated. This method is useful as it leads to statements about causation, leading to helpful suggestions for further study and investigation (Burns, 1990). There are, however, some problems with quantitative research. Huge samples are necessary in order to generalize for that population, which was not feasible in this study. There must also be strict levels of control.

When quantitative data is combined with qualitative research some productive data can be obtained. Qualitative research relies more on the human aspect of research, often involving interviews, observations and surveys, such as in this study. Interviewing ensures that all factors are taken into account when data is gathered, so we know the context in which the information was received. Interviews also provide more detailed information (Burns, 1990), ensuring the research has depth.

Participant observation is a common element in qualitative research (Denzin & Lincoln, 1994). This particular form of observation involves the researcher interacting with the participants and developing a bond with them in order to explore their behaviour. Participant observation was used in this study to notice changes in student performance and attitude.

The descriptive survey aims to 'estimate as precisely as possible the nature of existing conditions or the attributes of the population' (Burns, 1990, p. 344). Thus, this is a useful method for establishing attitudes to a given topic, such as using calculators in the primary classroom. An advantage of using surveys is only a small amount of time is necessary to elicit information from the respondents.

The design used in this study consists of a pretest, instruction period and posttest format. Similar methods have been used by numerous researchers to investigate student performance after using calculators (e.g. Hedren, 1986; Lowerre, Scandura, Scandura & Veneski, 1978; Leechford & Rice, 1982; Standifer & Maples, 1981).

CHAPTER III

METHOD

Design

The study involved the collection of a combination of qualitative and quantitative data. The quantitative data related to the whole class in regard to achievement and attitudes, as well as the attitudes of the parents. Teacher-made tests and questionnaires were used to collect this data. The qualitative data mainly related to six chosen children and the classroom teacher. This data was collected by means of interviews and observations.

Interviews were conducted with the classroom teacher before and after the study as this was deemed the most appropriate manner to investigate changes in her attitude to using calculators in year one. Interviews were also conducted with the six chosen children to get a better understanding of how they felt about using calculators.

Questionnaires were also used to assess student attitudes to mathematics and using calculators, and this questionnaire was administered both before and after the study. A different questionnaire was given to the parents at the completion of the study to assess their attitude to using calculators in year one.

Observations of the children, and in particular the six chosen children, were recorded in a researcher journal in order to assess changes in the students.

Participants

The research was conducted in a metropolitan primary school. Many of the parents of the children at the school are professional people, and at the junior primary level tend to become quite involved in the school life. Twenty-three Year One students from the same class were involved in this study. The class was chosen on the basis of convenience, rather than randomly selected. The participants included 10 males and 13 females. Six students were selected (after consultation between the researcher and classroom teacher) to be observed and interviewed. These students included three males and three females. For each gender there was a low, average and high ability student as identified by the teacher.

The classroom teacher was also a participant in the study. The teacher has been teaching for over twenty years and has had much experience with year one students. The parents of the children were also participants in the study.

Materials

The students all had access to their own four-function calculators, provided by the researcher for the duration of the study, during the mathematics lessons. Other concrete objects were also made available for them to manipulate; for example, unifix cubes. The students were tested before and after the instructional phase of the study using a teacher-made test relating to their knowledge of patterns (see Appendix 1). Students were also surveyed at the same times regarding their attitude towards

mathematics and calculators (see Appendix 2). The classroom teacher was interviewed before and after the study regarding her thoughts on the use of calculators in a year one classroom (see Appendix 3). The parents were surveyed at the completion of the study about their attitude to using calculators in mathematics classes (see Appendix 4).

Sources of Data

This section will describe the five sources of data used for the research study.

Interviews

Interviews were conducted by the researcher with the classroom teacher before and after the instructional phase of the study. The questions used at the two interviews were almost identical. An audio-tape recording was taken at both interviews and these were transcribed (see Appendices 5 and 6).

Interviews were also conducted by the researcher with the six chosen students. Each child was asked the same questions, and they had a calculator in front of them to relate to and use if they wanted. These interviews were also audio-taped and transcribed.

Questionnaires

Questionnaires were used to assess student attitudes to mathematics and calculators before and after the study. Overall changes in answers to the questions were noted when comparing the two questionnaires.

Questionnaires were also used to assess parent attitudes to using calculators in class. The parents were given the questionnaire at the completion of the study. There was also ample room for parents to write comments to clarify their answers, and some chose to do this.

Teacher-made Test

The teacher-made test was made by the researcher after considering what content should be covered when studying patterns. The same test was given both before and after the study, and differences in the number of correct responses were noted.

Researcher Journal

The researcher journal was used to make notes of what had happened in each lesson. The procedure of the lesson was noted, as were individual comments made by the students, teacher, and feelings of the researcher. Notes were also made in the journal of the six children who had been chosen to be observed.

Childrens' Writing

The students also wrote about calculators during one of their normal writing sessions in the last week of term. These writing samples were collected and analyzed to investigate the students' attitude towards calculators and what they had learnt from using them.

Procedure

Written permission was obtained from the Principal before the study commenced. The classroom teacher also agreed to participate in the study. The teacher was interviewed at the very start of the study so her attitude would not be affected by any information she heard about the study. The teacher was then consulted to ensure she agreed with the various aspects of the study, and she was asked not to demonstrate any positive or negative attitudes to the study in front of the students, as this may have affected their perceptions of the study.

The study took place during Term 3, for the entire term (consisting of ten weeks). The researcher taught all calculator lessons. The lessons took place one day a week for approximately forty minutes. During the first lesson the students filled out the questionnaires and completed the test. They were then asked all the things they knew about calculators, and this was recorded. Students were then allowed free play on the calculators. For the next eight sessions the students were engaged in a variety of mathematical activities focusing on pattern development, using calculators as well as other concrete manipulatives. During the tenth session the students completed the same questionnaire and test as they did in the first session.

Six selected students were interviewed after the final session to learn more about what they had learnt and the effects of using calculators. The teacher was also interviewed again after the tenth session to see if her perceptions of calculators in year one had changed, and the parents were

asked to fill out a questionnaire regarding their thoughts on calculator use in mathematics for year ones.

During the last week of term the students were also asked to write about calculators during one of their normal writing sessions. The students were free to write what they wanted about calculators.

Methods of Data Analysis

The first research question, regarding the students' understanding of patterns, was answered by comparing the students' tests on patterns from before and after the study to see how the students have developed in their ability to recognise, describe and continue patterns. Data from the six students who were observed and interviewed was also analyzed to see how their understanding had changed. This included analyzing the researcher journal.

The second research question, regarding the attitude of the students towards mathematics, was to be answered by analyzing both questionnaires (before and after the study) to see differences in attitude, as well as the students' interviews to see how their attitudes had changed and why.

The research question about the attitude of the classroom teacher was answered by comparing the interview with the teacher before and after observing the students using calculators. The question of the attitudes of the parents was examined by analyzing the questionnaires they filled out at the completion of the study.

Validity and Reliability

Reliability refers to 'the extent to which a test or procedure produces similar results under constant conditions on all occasions' (Bell, 1987, p. 50). Validity is the extent to which an item 'measures or describes what it is supposed to measure or describe' (Bell, 1987, p. 51). Both reliability and validity are essential in any research in order to show that your findings are meaningful

Reliability was established by ensuring the two tests were given under the same conditions. The researcher administered both tests, at the same time of day and same day of the week, to ensure environmental conditions did not affect the results of the tests. Each item in the test was read aloud to ensure all students understood what they had to do in order to get a reliable result. Reliability was enhanced by outlining the research questions, explicating the theoretical basis of the research, and explaining the data-gathering procedures.

Validity was established by using the process of triangulation. The two sets of tests were shown to an independent teacher to guarantee the correctness of an answer was agreed upon by an unbiased person. Triangulation was also used to evaluate the researcher journal to ensure interpretations of comments made were agreed upon.

Limitations

The small sample size in the study limits generalisability. The students were also not randomly selected so it is not feasible to say that they are a

good representation of students of that age. A large sample group was not possible in this case, but the six selected students were chosen to represent different ability levels and both genders. The time span the study was conducted over was very short, spreading over only ten weeks, so this is another limitation of the study. The lack of any kind of control group should also be considered a limitation.

CHAPTER IV

THE LESSONS

Week 1

The instructional phase of the study started by giving the students the pretest to complete. An enlarged copy of the test was put on the board so the children could follow each question without getting lost. The children were made aware that it was a test and that they were not supposed to look at their friends' work. It was also explained that they might find some of the questions difficult as they had not covered that content in previous lessons. Each question in the test was read aloud and the students were given enough time to answer the question before the next question was read out. The researcher pointed to each question on the enlarged copy as it was read aloud to ensure the students knew which question they were supposed to be looking at. When the test was completed the papers were collected.

Next the questionnaire was distributed, and the same process was used for this as had been used for the test. After the questionnaires were collected the children sat in a group around the whiteboard, where they were first introduced to the calculators. A class discussion about calculators was initiated, with over half of the class saying they had used a calculator before. However, when asked how many had their own calculator at home, only a few children answered positively. Next, the children were asked what they knew about calculators, and their responses were written on a large sheet of paper. Many children had at

least one response to the question, with answers ranging from 'you can do pluses on them' to 'they give you information around the world.' A selection of responses is given in Appendix 7.

After this, the children were given a calculator each and told to work in pairs and explore their calculators, discovering what they can do. The children enjoyed this immensely. There was much discussion between the pairs of students, and they asked many questions about the calculators. Most wanted to know how to turn it off, how to get rid of the 'M' and how to read the numbers they had put on the calculator.

During the free play many of the students experimented by putting their phone number, age and/or house number into the calculator. Many also just appeared to press the different buttons on the calculator to see what they did. Some children also did various computations on the calculators, and one student asked if she could use a piece of paper to write the computations on, which she did. Another girl, Michelle, asked how to put infinity on her calculator. When asked what infinity is she replied that it is the biggest number you can get, it just keeps going. She therefore came to the conclusion that she wouldn't be able to show it on the calculator.

After about ten minutes of free play the class came back together as a group and the students shared with the rest of the class what they had done. All pairs were enthusiastic to share what they had done. During this time the basics of using calculators were also discussed, such as how to turn it on, how to clear the screen, how to turn it off, how to do addition and subtraction computations, and how to put in their phone numbers.

This concluded the lesson, but the students were reminded that the calculators were going to be left in the class for them to use when they had free time.

Week 2

The second session started with a class discussion about patterns. The children gave their thoughts about what patterns are, and about half appeared to have some idea of what a pattern is. Of these children most referred to patterns only as geometric shapes. We concluded the discussion by summarising that a pattern is something that is repeated, and the children appeared to grasp this concept.

The students were then asked to key in 151515 on their calculators. When asked if this was a pattern, most replied it was. They were then asked to key in the next two digits in the pattern, which they did. This was recorded on the worksheet (see Appendix 8) after it was modelled on an enlarged copy on the board. Next the children were asked to see if they could find a way to show the same pattern using unifix cubes. A few students had trouble with this and needed individual help. This pattern was then drawn on the worksheet (after being modelled), and the process was repeated for a new pattern. After this, the students had a chance to make up their own pattern, which they appeared to enjoy doing.

This worksheet appeared difficult for some children, as they weren't sure what they had to do. This may have been the idea of showing a pattern on a calculator, and then the same pattern using cubes, was new to them. As

a result, the lesson took longer than expected so the children who needed help could get individual attention. The children appeared to enjoy the challenge and stayed on task during the lesson. However, a few children did ask when they were allowed to just play on their calculators as they had the week before.

Week 3

At the start of the third lesson the students were shown the worksheet (see Appendix 9). The researcher explained that it was all about patterns. The students were given instructions on what they had to do with the worksheet, and they were told that they would be working in pairs again, before the calculators and worksheets were distributed and the students went to work. They appeared to enjoy working in pairs, and they worked well together, remaining on task. The researcher observed the children while they were working and asked questions of the children to make sure they knew what they were doing. The students were all able to complete the worksheet without any problems. The students who finished early were then asked to use unifix cubes to make some of the patterns on the worksheet. All students appeared confident doing this after the previous week, however, not all students had a chance to use the cubes this lesson as they didn't finish their worksheet.

So far the children had been showing a real interest in using calculators. For example, Michelle said during recess that she was sick and wanted to go home, but when asked if she was going to stay for the calculator lesson

she became much more excited, and said she would wait until after the calculator lesson before going home.

Week 4


The researcher began by revising what a pattern is, and then explained that this lesson was about growing patterns. It was explained that growing patterns were patterns that 'grew' by the same amount, e.g. numbers that went up by twos. The class then keyed in the numbers 12345 in their calculators as directed. The class discussed what was happening in this pattern; that is, the numbers were getting bigger by one each time. The children then volunteered what the next numbers would be, and these were keyed in to the calculators. This was recorded on the worksheet (see Appendix 10).

Next the children were challenged to find out how many cubes would be needed to make this pattern. At first, most children said eight. As a result, the researcher started making the pattern with cubes and showed how the total would be all the numbers added together. The children could not find a way to discover the total number, so they ended up guessing numbers, with some children getting quite close (e.g. 30) while others were just making wild guesses (e.g. 100). The children then made the pattern with cubes in the groups they were seated in. This was difficult for some children, as they were not used to working in small groups, and they wanted to make the whole pattern themselves.

The rest of the worksheet was finished without any problems and the results were quite impressive. The children were asked to make up their own growing pattern (still only growing by one), starting at a number other than one. Most children did this very well. Some, however, still started at the number one, but continued the pattern until it was more or less than eight. David made a pattern that was decreasing by one (see Figure 4).

Figure 4.

David's Growing Pattern.



A handwritten sequence of numbers: 10, 9, 8, 7, 6, 5, 4. The numbers are drawn in a simple, slightly irregular style, with the '8' and '6' having loops. They are arranged horizontally from left to right, showing a decreasing pattern by one unit.

Phoebe made a long pattern, starting from 20 and going up until 30. She wanted to keep going but ran out of time. James also made a very long pattern, starting from 14 and continuing until he ran out of room at 42.

Overall, this lesson appeared to go very well. It was a very directed lesson, but this was useful to introduce the topic of growing patterns. All the children appeared to adapt the lesson to suit their level of development; for example, Mark made a pattern that was very short (only 4 numbers) but it still fit the criteria of growing by one and starting at a number other than one. Monique found it easier to draw the pattern first, as it would look as if made with cubes, then to write it as it would appear on the calculator. Phoebe (above average ability) extended her work by creating a long pattern (11 numbers), and only ended it because she ran out of time.

Week 5

The lesson this week continued on the topic of growing patterns. First the class revised what a growing pattern is and then the students were shown an enlarged hundred square (a ten by ten square with numbers from one to one hundred) on the board. The class discussed how each number was getting bigger by one, and then they were shown how to count by ones on the calculator by pressing $1 + = = =$. The students practised this to make sure they could do it. The students then went into pairs and counted by ones on their calculators, covering the numbers on their hundred square with counters as they were displayed on the calculator.

Some children became distressed during this lesson because they kept bumping their sheet and the counters would move. After this happened a few times they were much more careful not to bump the sheet. This activity allowed the students to work at their own pace. Only a few students actually got to the end of the hundred chart, but all the other students had done at least half of the chart.

Week 6

The researcher first revised what a growing pattern is. The class was also reminded how to count by ones on the calculator, and this produced the question of how you could go about counting by a different number on the calculator, for example counting by 5s. The students realised that instead of $1 + = = =$ they would need to put in $5 + = = =$. The class then tried counting by 5s, and some were quite surprised to find the calculator went

straight from 5 to 10, missing out 6, 7, 8, and 9. The students also practised counting by a few other numbers, before they were introduced to the lesson for the day. The students were shown the long strips of paper (such as used in some calculators), and were told that they would use these to record their numbers on. They were told to work in pairs and invited to count by any number they chose.

The children found a partner, got their materials and went to work. The children appeared to enjoy working in their pairs and being able to choose what number they wished to count by. The idea of recording it on a long strip of paper also had a novelty effect which they enjoyed. Many students filled up their first strip of paper quite quickly and had to attach another strip so they could keep the pattern going. Seven of the children were enjoying it so much and were working so well that they were on to their third strip of paper before they ran out of time.

For the last ten minutes of the lesson the students sat on the carpet in a group and took turns sharing what they had done with their partner. It was obvious that most felt quite proud of their work, especially as it was such a long piece of paper. The students were encouraged to predict what number they would reach if they kept the pattern going until the end of the strip, but some children were quite hesitant about this estimation.

Many students complained at the end of the lesson that they didn't want to stop. One advantage was that the activity was suited to different levels of the children. For example, Joshua, who is a very intelligent boy, decided he knew how to count by twos already and didn't have to use a calculator.

He started writing the numbers on the paper and got up to 42 before he became stuck and didn't know what number was next. When shown how the calculator can continue counting in twos he became very enthusiastic and kept the pattern going until it was time to share with the rest of the class what they had done.

Week 7

Lesson 7 was very similar to lesson 6. First the class reviewed what they had done the week before then they went into pairs and did the same counting on the calculators and recording on strips of paper. Once again, the students chose the number they wanted to count by, so they would have some control over their learning. Appendix 11 shows the variety of numbers the children chose to count by, and how far their counting went.

Quite a few students had problems continuing counting by a certain number for a long time. This may have been due to the fact that they accidentally pushed a wrong button, as they may have been counting by 10s and suddenly the numbers would jump from 120 to 1600. However, most of the children were able to pick up such inaccuracies, and approached the researcher saying something had happened to their pattern. This shows their ability to follow the pattern and pick up major discrepancies. Many children were also checking their partners' numbers to make sure they were both getting the same numbers. However, not all discrepancies were noticed by all children.

The strips of paper were collected from the students at the end of the lesson so the researcher could see exactly what they had done. They were also to be used in the next lesson.

Week 8

After reviewing what the class had done in the previous week the students were given back their rolls of paper. They were also given a hundred square and told that they were going to use one coloured pencil to colour in all the numbers that they had written on their strip of paper. It was explained that this was another way of recording the numbers in your pattern. This was demonstrated for the students to see. Six students whose pattern was too big to fit on the hundred square, or wasn't a consistent pattern, were called out the front to select a different pattern from the spare strips of paper to work with.

The students appeared to enjoy this. They stayed on task and were quite amused by the patterns they were creating. Most students were able to see what was happening in their pattern, and continued it without referring to the strip of paper. Others, however, needed some prompting to see what was happening, and then continued this.

When the students had finished their pattern, they used the calculators to count by another number, and showed this pattern on another hundred square (on the back of their sheet). At least half of the class asked for a second sheet to continue more patterns, and David and Paul even got onto a third sheet. These boys were told they could have free play on the

calculators after finishing the second sheet, but they asked if they could have another sheet to continue more patterns, and were excited when they were allowed to do this.

For the last ten minutes of the lesson the class came back together as a group so the children could share their findings with the rest of the class. Once again all students were keen to share their work. When they were reporting what they had done it was obvious they understood what was happening in their pattern. For example, Brooke said that when counting in twos you just coloured every second number. After colouring the numbers in the first two rows Brooke knew which columns she would have to colour, without checking each number individually. Most told the students that they continued the pattern without looking at the strip, as they knew what was going to happen.

The students were again using their reasoning skills in this lesson, as when they missed a number on their strip of paper that should have been in the pattern, they picked it up when colouring the hundreds square. This was because they could see what was happening in the pattern, and it was obvious if a number was left out of the pattern. Appendix 12 contains examples of children's work during this lesson.

Week 9

Week 9 was planned as a review of what had been covered over the previous 8 weeks. A few patterns were put up on the blackboard and the students had to key these into their calculators and fill in the next two

digits. They also had to use unifix cubes to make these patterns. Next the class discussed what growing patterns were, and how to count by certain numbers using a calculator. After this, the children had a choice either to make growing patterns and record it on a strip of paper or on the hundreds squares. They set off in their pairs and went straight to work, counting by all sorts of interesting numbers. At the end of the session the class once again shared what they had done during the lesson.

Week 10

This session was very similar to the first session. The students were given the same test again, and the same instructions, but this time they had the option of using a calculator if they wished. When the test was finished they were given the same questionnaire as in Week 1, and it was explained in the same manner. Next, the class sat in a group around the whiteboard and were asked what they knew about calculators. This was written on a large piece of paper (see Appendix 7). The session was then concluded, and the students were told that all the calculator lessons the researcher had been doing with them had finished and she would be taking the calculators back. Quite a few of the children remarked that they didn't want the calculators to go.

Summary

Overall the class really appeared to delight in using the calculators. The students remained on-task virtually all the time, and the calculators appeared to cater to the different ability levels of the students. The

classroom teacher observed most of the lessons taken, and gave very positive feedback to the researcher about the lessons.

CHAPTER V

DATA ANALYSIS

Student Performance

The pretest and posttest consisted of six questions involving written answers. The mean score on the pretest for males was 69 percent, and for females 66 percent. The overall mean for the pretest was 67 percent. On the posttest, the overall mean score was 88 percent, with both males and females having a mean score of 88 percent. A summary of student performance is shown below.

Figure 5.

Percentage of Correct Responses in Pre- and Posttest.

Question	Pretest	Posttest
Identify a pattern of cubes	95.4%	100%
Identify repetitive pattern of numbers	100%	100%
Identify decreasing growing pattern	40.9%	36.4%
Continue 2 digit repetitive pattern	95.4%	100%
Continue 3 digit repetitive pattern	90.9%	100%
Continue pattern of cubes	77.3%	68.2%
Continue growing pattern*	95.4%	100%
Show a pattern on a hundreds square	31.8%	100%
Show what a pattern using cubes would look like on a calculator	18.2%	100%
Show what a number pattern would look like if made with cubes	36.4%	95.4%
Make up own pattern	50%	100%

* Some students treated this as a repetitive pattern rather than a growing pattern.

The pretest showed 95.4 percent of students could correctly identify a pattern of cubes, and in the posttest 100 percent of students correctly identified this. In both the pretest and posttest 100 percent of students correctly identified a repetitive pattern of numbers, but only 40.9 percent of students in the pretest identified the numbers 9 8 7 6 5 4 3 2 as being a pattern. On the posttest this dropped to 36 percent who correctly identified this as a pattern.

The pretest showed 95.4 percent of students could correctly continue a '12' pattern for the next two integers, but this increased to 100 percent on the posttest. The pretest also showed 90.9 percent of students correctly continued a three digit pattern, and this also increased to 100 percent on the posttest. Interestingly, 77.3 percent of students on the pretest correctly continued a pattern showing cubes, but only 68.2 percent of students on the posttest could do this. Another improvement was seen in the ability to correctly continue a growing pattern. The pretest showed 95.4 percent of students were able to correctly continue a growing pattern, and 100 percent of students were able to do this on the posttest.

Using a hundred square, 31.8 percent of students in the pretest correctly shaded in numbers to make a pattern, and 100 percent of students could do this on the posttest. Only 18.2 percent of students in the pretest could show what a pattern using cubes would look like on a calculator, but this increased to 100 percent of students in the posttest. Few students (36.4 percent) could show what the pattern 1 2 3 1 2 3 would look like using cubes in the pretest but 95.4 percent of students could correctly show this

in the posttest. Only 50 percent of students in the pretest could correctly make up their own pattern, but this increased to 100 percent of students in the posttest.

It is also worth noting that 29.5 percent of students on the pretest incorrectly identified numbers and cubes as patterns, and 27.3 percent of students on the posttest incorrectly identified these as patterns.

Discussion

The results from the two tests indicate that students were more able to correctly identify a pattern after the study. However, the percentage of students who correctly identified the numbers 9 8 7 6 5 4 3 2 as a pattern decreased after the study. This may have been due to the fact that in the pretest some students (18.2 percent) ticked all boxes, saying they were all patterns. Although these students got some correct responses it indicates that they did not really understand what a pattern is.

On three of the four questions where students were asked to continue various patterns there was an increase in the number of students who could do this on the posttest, with 100 percent of students being able to complete the three patterns on the posttest. However, on the question in which the students had to continue a pattern that illustrated cubes the students did better on the pretest than posttest (there was a decrease of 9.1 percent of students being able to do this on the posttest). This could have been due to careless error, as students may have seen this as an 'a b' pattern instead of an 'a b b' pattern. However, there was one student on

the pretest who completed the pattern using stars instead of squares, but this was not evident on the posttest. The use of stars illustrate her lack of knowledge of patterns.

The last pattern in this section was intended as a growing pattern but some children treated it as a repetitive pattern and this was still marked correctly. Of the students who got this question correct, 61 percent of students in the pretest continued the pattern as a repetitive pattern; that is the pattern was 3 4 5 6 7 and they put the next two numbers as 3 4. In the posttest only 29 percent of students who got the answer correct repeated the pattern, the rest continued it as a growing pattern, i.e. 3 4 5 6 7 8 9. This indicates that the students had learned that there are more types of patterns than only repetitive ones.

The fact that students could use a hundred square to make patterns also indicates their knowledge of growing patterns. Before the study only 31.8 percent of students could use the hundred square to make a pattern. However, many of these students were not so much using the numbers to make the pattern, but were using the boxes around the numbers to make a geometric pattern. For example, in Figure 6 the child has shaded in boxes to make a diagonal pattern, but is not really relating to the numbers used. In the posttest students were making growing patterns, and were directly using the numbers to do this.

Figure 6.

A Child's Interpretation of a Pattern Using a Hundred Square.

	2	3	4		6	7	8		10
11		13		15		17		19	
21	22		24	25	26		28	29	30

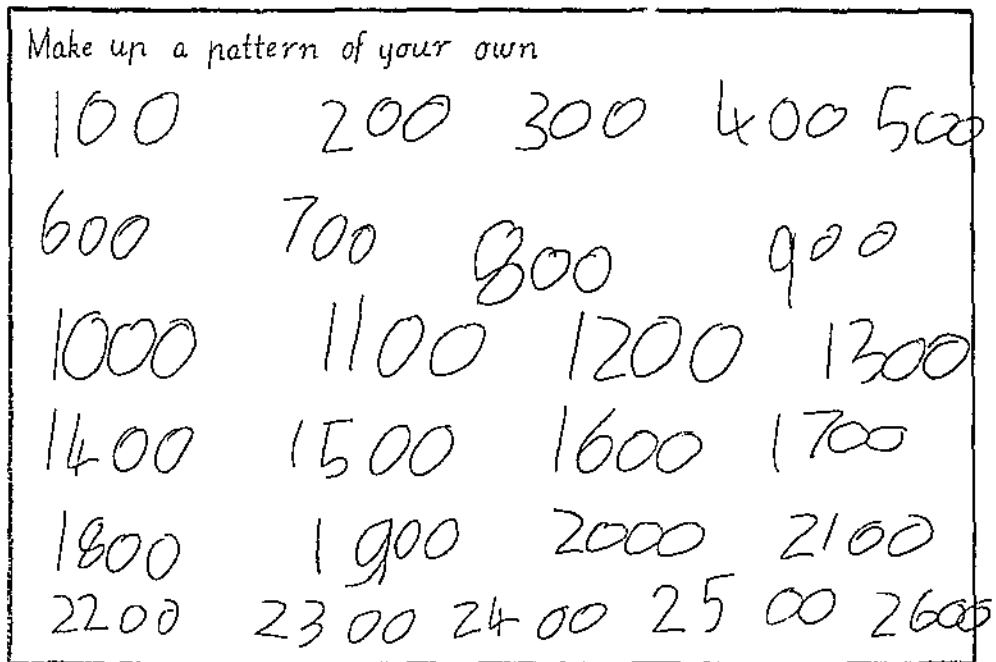
The question which showed a pattern made from cubes and asked the children to indicate what it would look like on a calculator produced some interesting responses in the pretest. Only 18.2 percent of children answered this question correctly in the pretest. Other responses included the word 'different', illustrating that the child knew you couldn't show the pattern in the same way, but could not decipher how it would look on a calculator. Another child coloured in the squares green, and when questioned about this, she responded that 'it would look the same but it would be green'. In the posttest, 100 percent of students could answer this question correctly.

The next question required the students to do the opposite. The students were given the numbers 1 2 3 1 2 3 and they had to show what this would look like with unifix cubes. Only 36.4 percent of students answered this correctly on the pretest, but 95.4 percent were correct on the posttest. These two questions indicate that after the study the children were more able to show patterns using a variety of materials or ways, rather than in one fixed manner.

Only 50 percent of students in the pretest could make up their own pattern, but 100 percent of students could make up their own pattern in the posttest. Those who did make up a pattern in the pretest mainly made up patterns using geometric shapes. However, in the posttest a much greater range of patterns were exhibited. Some did have shapes that had been repeated, but others had repeated numbers (using six numbers before repeating the pattern in one case), some illustrated using cubes to make patterns, and others made their own growing patterns. Figure 7 shows an example pattern from the posttest.

Figure 7.

Derek's Growing Pattern.



Overall, the test results indicate that student performance has increased after using calculators for a period of one term. The mean average on the test increased from 67 percent on the pretest to 88 percent on the

posttest. In general, the students were more able at the end of the study to correctly identify patterns, continue patterns, show a pattern in another way and make up their own patterns. The tests indicate the students also have a wider understanding of what patterns are and realise that there are many types of patterns.

During the lessons the children also demonstrated an increased ability to read large numbers, which they do not normally meet in year one. Several children became quite confident in counting by nine millions, and many children would approach the researcher or classroom teacher to ask what was the number on their calculator display.

Student Attitudes

Questionnaires

Generally, students were fairly positive towards both mathematics and calculators before the study commenced. However, Figure 8 shows how this changed, in a positive direction, after the instructional phase of the study finished. Overall, the students were more enthusiastic towards mathematics and calculators after using the calculators for a period of one term.

Figure 8.

Changes in Student Attitudes to Mathematics and Calculators.

Question	Before/After Study	Yes	No	Don't Know
1. Maths is fun	Before	54.5%	31.8%	13.6%
	After	68.2%	0%	31.8%
2. I like maths	Before	63.6%	27.3%	9.1%
	After	72.7%	18.2%	9.1%
3. Calculators make maths fun	Before	72.7%	13.6%	13.6%
	After	90.9%	0%	9.1%
4. Maths is easy	Before	63.6%	18.2%	18.2%
	After	72.7%	4.5%	22.7%
5. Maths is easier if a calculator is used	Before	72.7%	13.6%	13.6%
	After	86.4%	0%	13.6%
6. It is important that everyone learns how to use a calculator	Before	63.6%	13.6%	22.7%
	After	72.7%	18.2%	9.1%
7. Calculators are only needed when you are older	Before	18.2%	45.4%	36.4%
	After	18.2%	68.2%	13.6%

Before the study, slightly over half of the children thought mathematics was fun, but almost a third said it wasn't fun. After the study, however, more than two thirds said they thought mathematics was fun and no children said they thought mathematics wasn't fun. There was, however, an increase in the number of children who responded by saying they didn't know. Figure 8 also shows an increase in the number of children who said they like maths after the study was completed. Almost all children (90.9 percent) agreed that calculators make mathematics fun, an increase from 72.7 percent before the study. The majority of students (86.4 percent) believed that calculators make mathematics easier after using the calculators, while none disagreed with this statement, although 13.6 percent of children were unsure. There was also an increase in the

number of children who thought it is important for everyone to learn how to use a calculator, as well as an increase in children who didn't think it is important for everyone to learn how to use a calculator. However, the number of children (18.2 percent) who thought not everyone needs to learn to use a calculator was small in comparison to those who thought they did (72.7 percent).

Only 18.2 percent of children said calculators are only needed when you are older, and this percentage was the same both before and after the study. However, there was an increase in the percentage of children who thought they should be using them now, not just when they are older. More than two thirds (68.2 percent) of children after using calculators thought it was important for them to be using them now, not just when they are older, whereas before the study less than half (45.4 percent) of children had this view.

Writing about Calculators

The writing the children produced showed a distinctly positive attitude towards calculators. Most children (76 percent) mentioned in their writing how much they liked using calculators or thought they were fun. Not one child said anything negative about calculators in their writing. See Appendix 13 for samples of children's writing.

Student Interviews

The six selected children who were interviewed all showed positive attitudes to calculators. All replied positively to the question concerning

whether the children liked using calculators. When asked about what they like about using calculators answers ranged from 'making patterns and playing banks' to 'pressing the buttons' and 'they make things easier'. When asked what they didn't like about using calculators, some very interesting answers arose. Both Rebecca and Mark showed an animosity about not being able to turn the calculator off, since they were solar powered. Mark replied 'there's no way to turn it off, you have to put that away (putting hand over solar panel). I hate that bit.' Rebecca also disliked this, because 'it takes too long' to turn it off. The other thing Mark disliked about using calculators was that if you pressed 59, the 5 would be in front of the 9, where as he thought it should have been the other way around. Phoebe replied that she didn't like it when something happened and she didn't know what to do. For example, if she accidentally pressed a wrong button she didn't like not knowing what had happened to the display. David said he didn't like doing computations on the calculator, he would rather use 'counters and things like that' for doing computations. Joshua, who is above average in his mathematical development, replied that he didn't like 'just putting patterns on them and all that stuff'. He much preferred doing his own thing, especially when he could use big numbers like 9 000 000. Monique, however, replied that there was nothing she didn't like about using calculators, she thought they were great.

Discussion

The data indicates that the children were more enthusiastic towards mathematics and the use of calculators after being subject to the study.

The use of calculators definitely appears to be motivating for the children, as 90.9 percent of students said after the study that calculators make mathematics fun. This increased enthusiasm towards mathematics may have been one of the reasons the children performed better in the posttest, as they had been motivated in the lessons and so learnt the required content.

The fact that 18.2 percent of children, both before and after the study, thought calculators are only needed when you are older, is quite interesting. The researcher was told by one of these children that 'you need to learn how to do things with a pencil and paper before you use calculators. My Mum told me that, 'cause otherwise you don't learn anything'. This statement shows the impact parents' attitudes have on children and their learning and beliefs.

The increase in the percentage of students who said they didn't know if maths was fun is intriguing. Whether this was due to the students unwillingness to give a definite answer or because they thought it was fun sometimes but not at other times is not clear. Another possible reason for this answer is that they were not sure exactly what 'maths' was. From this data it is not clear why there was an increase in children responding 'don't know', but interviews may have cleared this up. However, of the six children who said 'no' before the study, three in the posttest said 'yes' and three said 'don't know', so all moved in a positive direction.

The students all demonstrated their enthusiasm for exploring the calculators in their pairs, and one of the aspects that the majority of

children in the class found fascinating was the square root key. The students would get a lot of enjoyment from putting a number on the screen and then pressing the square root key over and over. They would watch with fascination as the numbers changed, and although they didn't understand what was happening to the numbers they could identify that it was changing the number. Even in the children's writing their affection for this button was evident, with more than one child writing about this special key.

Teacher Attitudes

The classroom teacher, Elaine, was very enthusiastic for the study to take place in her classroom so she could gain some new ideas. Elaine has her own calculator and uses it approximately three times a week for 'paying the bills and working things out, balancing my checkbook and things like that'. She also has observed her son using a calculator for a variety of purposes, from checking his homework to working out the exchange rate when he went on a trip to Africa.

Elaine has previously used calculators in the classroom, when she had a split three/four class. In this class the calculators were used as a regular activity in conjunction with a mathematics textbook which told the class when to use the calculator. These lessons mostly focused on using the calculators for doing computations. It was Elaine's opinion that most of the teachers in her school would use calculators, but she was unaware how often they were used. 'A lot of the maths books that we get now have set calculator activities and the kids are told to get the calculators to do the

activities'. Elaine's experience with using calculators with year ones is mostly related to the children playing with the calculators when they have a shopping centre set up in the classroom.

Elaine has had no professional development relating to calculator use in the classroom. She never formally learnt how to use a calculator because 'we didn't have calculators when I was young, and we didn't have calculators when I was in teachers' college'. Elaine did show an interest in learning how to use calculators, 'particularly if I was going back up into the higher grades. I think I would have to learn what to do'.

Before the study Elaine felt that 'obviously they (the year ones) would need to be exposed to calculators' but she felt they needed experiences with concrete materials before using calculators. She felt that year one was a good time for students to start using calculators, but that 'it'd have to be definitely in the second half of the year', after they have learnt to do addition and subtraction. 'You couldn't really introduce calculators in this classroom until they've done that'.

Elaine saw benefits in using calculators in that it is technology and the children therefore have to know how to use them. She identified that children would be able to recognise numbers from using calculators, and that it is another approach to teaching addition. The only disadvantage she saw with using calculators was that if you 'introduced it to a group of children that didn't understand what they were doing to start with, they would just be mindlessly copying down answers but they wouldn't really know what it meant'.

When asked about the students' views on using calculators in class Elaine felt sure they would love it, because it's something different. She also felt the parents would have positive feelings about them 'because parents always want their kids to learn'. Elaine felt that the availability of calculators in the school was a problem, but if she had a set for her class, and it was the second half of the year, she would probably use them once a week. She felt using calculators would make her job easier, as it would motivate the children to learn. Planning was not seen as a major issue, but Elaine felt there would need to be more planning with the middle or upper primary grades than year ones.

The second interview with Elaine, after the study was completed, showed a definite change in her attitude to using calculators. Elaine had received a lot of new information about calculators over the course of the study and had seen that calculators could be used in a variety of ways. 'I have got a lot of new information and I can see the possibilities in the classroom now. I mean, you were doing activities that I wasn't even aware of'. She felt that her attitude had changed after observing their use. Calculators 'definitely changed my views. I can see even using it at the beginning of the year just recognising numbers on the calculator would be an extra activity for the kids to use'. The following quote illustrates how her attitude changed :

'I wasn't against it before but maybe I didn't think you could use it until the kids had learnt, like, their addition and subtraction sums. But now I can see that there are lots more possibilities than I was aware of. And I can also see that having them in the classroom

has been good in activity time. Because the children get them out and use them and set up shops and they've been making money.'

Before the study, Elaine thought calculators shouldn't be used until the second half of year one, after they had learnt addition and subtraction. However, after the study she felt they should be used from pre-primary, 'or even younger, I suppose, if parents had them at home. But in the school environment, pre-primary.'

Elaine could not identify any disadvantages from using calculators, after observing the lessons, but felt there were many benefits.

'Just the fact that it would be another . . . piece of equipment that you would use to teach children, umm, things that you are already doing. And also, like the activities that you were doing, where they're doing multiples of twos and threes. They've got a chance to write numbers of much higher, umm, level. Much higher numbers than they normally could use, because they can copy them from the calculator, they were writing down 680 and 682, things like that, which they wouldn't normally be able to do.'

This was a big change from her attitude before the study, where she mentioned that year ones only had to learn up to the number ten. After observing the lessons it appears she was more able to see the capabilities of the children. 'Everything that you've done, I would repeat now next year.' This statement shows the positive feelings the teacher had for the calculators after observing her class using them.

Elaine felt the students had really enjoyed using the calculators, and that they had a very motivating effect on the students. She still held the opinion that using the calculators would make her job as a teacher easier because it is another way of explaining things.

Another change in Elaine's attitude after the study was the amount of planning she thought it would require. She thought it would take more planning than she had originally thought.

'Having seen the books you gave me and had a look at the activities that are in there. Yes, it would be. Otherwise you just stick to the same things that you know about, like I just thought you would use it for adding and subtraction. You'd be limited, so you really need to plan out what you're going to do, and have a look and go back to your books and just check.'

When asked if she had any further comments she would like to make about calculators or the study, Elaine replied:

'Well it's been great. It opened my eyes, you get so narrowed in with what you're doing that you're not aware of, sometimes, all the possibilities. So, no, for me it's been really beneficial, and for the children.'

Discussion

After observing the students using the calculators Elaine was much more enthusiastic about their use. She was already fairly positive towards their

use at the beginning of the study, but this enthusiasm intensified when she actually saw her class using them and the benefits this was creating. The fact that Elaine never learnt how to use a calculator appears to have had an influence on her, as she was a bit intimidated by them because she didn't know how to work them properly. She also saw them as very limiting before the study as she was not aware of the potential calculators have. In-service training would definitely have increased her likelihood of using calculators as she would have known how to use them and what types of activities she could do with them.

Parent Attitudes

When the parents were first given the permission slip for their child to participate in the study, two parents approached the classroom teacher with concerns about the study. They were worried that the children would be mindlessly using calculators instead of learning how to do addition and subtraction by the conventional methods. When the teacher explained what the study involved the parents agreed that their children could participate. This was the only time any of the parents discussed the study with the teacher or researcher until the questionnaires were distributed.

The data collected from the questionnaires revealed that all parents agree that it is important for their children to learn mathematics. Almost three quarters of parents questioned (71 percent) said they thought calculators are enjoyable and motivating for mathematics, 7 percent disagreed with this, and 21 percent were uncertain. One of the parents who agreed with this comment said that calculators 'give them more control over getting

correct answers.' However, one of the other parents who also agreed with this statement made the comment 'only after they have mastered method with pencil and paper'. One of the parents who responded by circling 'uncertain' commented that it 'depends on how motivated, creative the teacher is'. The parents were much more divided on the issue of whether calculators encourage mental laziness. Only 21 percent of the parents agreed that calculators encourage mental laziness, 43 percent disagreed, and 36 percent were uncertain. However, the comments reveal much about why the parents came to this conclusion. One of the parents who agreed that calculators encourage mental laziness wrote, 'when using a calculator one is aware of patterns but not using the full switched on mental effort of computing numbers mentally'. Other parents, who disagreed with the statement, commented that they 'need to be used in conjunction with mental awareness' and that it 'depends on how they are used'. Two parents who responded with 'uncertain' made comments saying that it depends what the calculators are used for. 'If they are used in primary schools for mathematics calculations they do encourage mental laziness', was one response.

Only 29 percent of parents said that calculators should be used in year one mathematics, 29 percent disagreed with this, and 43 percent were uncertain. Some of the parents who agreed with this said they should be used 'for variety and for patterns', and that children 'need to understand their use just like computers'.

Over a third of parents (36 percent) agreed that calculators shouldn't be used in mathematics until students are older, 21 percent of parents disagreed, and 43 percent were uncertain. One parent believed that 'it's too late to introduce them then', while one of the parents who had responded 'uncertain' stated 'it depends on what they're used for'.

Very few parents (7 percent) agreed that their child had learnt a lot since using the calculators, 7 percent disagreed, and 86 percent were uncertain. The only comment provided by the parents for this question was that their child 'showed us a couple of tricks we weren't aware of', but did not say what sort of 'tricks' these were.

Of the parents who responded to the questionnaire, 14 percent thought using a calculator gave the students more control over their learning, 14 percent disagreed and 71 percent were uncertain. No comments were provided to give further explanation for these views.

When asked whether calculators should be freely available in the mathematics classroom, 21 percent of parents agreed, 36 percent of parents disagreed, and 43 percent of parents were uncertain. However, one of the parents who agreed with this stated this should be the case only when the students are older. One of the parents who was uncertain also said 'maybe in older children'.

Less than a third of parents (29 percent) believed the school should provide the calculators rather than the students buying their own, 36 percent disagreed with this, and 36 percent were uncertain. One of the

parents commented that if the parents provide them the students learn to 'take responsibility for expensive machines' but that parent also stated that 'people who can't afford one should be assisted'.

Over half of parents (57 percent) agreed that children shouldn't use calculators unless they have mastered the number work with pencil and paper methods, 29 percent disagreed with this, and 14 percent were uncertain. Of the parents who agreed with this, the comments they wrote included, 'I think both are important, not exclusively' and 'it is important to understand the basic methods and practice increases speed and stimulates mental computations'. Some of the parents who disagreed with this statement commented that 'there needs to be a balance' and that calculators are 'good for patterning and understanding of properties'.

Most parents (71 percent) agreed that calculators facilitate the learning of patterns. None of the parents who returned the questionnaire disagreed with this statement, but 29 percent of parents were uncertain.

Almost half of parents who responded (43 percent) agreed that there may be harmful effects if the children use calculators too much in the classroom. Only 14 percent of parents disagreed with this statement, and 43 percent of parents were uncertain. None of the parents included comments as to what sort of effects they expected if calculators were used too much.

No parents agreed with the statement that 'calculators in school are a bad idea, they will be stolen or they will break, or their batteries will run out.'

Most parents (85 percent) disagreed with this statement, and 15 percent were uncertain. As one parent pointed out, this statement 'can apply to everything – books, computers, pencils, etc – irrelevant point'.

More than half of parents (57 percent) agreed that calculators encourage discovery and investigational work, 7 percent disagreed and 36 percent were uncertain. No parents agreed that since tried and tested methods work calculators are really just an unnecessary bandwagon. 69 percent of parents disagreed with this, and 31 percent were uncertain.

The last section of the questionnaire brought out some interesting comments that further highlight the attitudes of the parents to their children using calculators. The following are some examples of these comments.

'There is a place for calculators in school but only after the kids have mastered the number system first by themselves. It's important for them to develop a self assurance with the system by themselves, and only periodic sessions with calculator as an introduction to them and a familiarisation exercise. They (calculators) are important and necessary at higher grades to speed up calculation work. If you introduce calculators too early in a child's education they don't master some very important basic, foundation skills thus creating lack of confidence in their own abilities to work things out.'

'I would prefer my child to learn basic mathematics first, before undertaking the use of a calculator.'

'I think calculators are interesting and do offer a good opportunity for children to learn about patterns. However, I would not like to see the children using calculators all the time until they have become competent at number work.'

Discussion

The common element in the comments made by the parents is their desire that children first learn mathematics using the traditional pencil and paper method. Once children have mastered this the parents appear happy for their children to use calculators, but it seems they fear if the students use calculators before doing computations with pencil and paper it will hamper the children's development.

The high percentage of parents who answered 'uncertain' to various questions indicates their lack of knowledge about the topic. Many parents did indicate a desire to get more information about using calculators with year ones. If the parents were made aware of major studies done concerning the use of calculators with young children there would probably be a much greater percentage of parents who are keen to have their children using calculators regularly. As a result of the parents' desire to learn more the researcher made a brochure for the parents concerning calculators and young children.

This study focused on pattern development in year one with the use of calculators, and 71 percent of parents agreed that calculators facilitate the learning of patterns. However, only 29 percent of parents felt that

calculators should be used in year one, although pattern development is an important aspect of year one mathematics. This indicates that parents must be kept up to date on the goals for mathematics education, and how using calculators can help achieve these goals.

CHAPTER VI

CONCLUSIONS AND RECOMMENDATIONS

This study has produced some useful data dealing with calculators and year ones. The best way to deal with this data is to relate it back to the research questions. The first research question was concerned with the ways in which the use of calculators affects students' understanding of patterns. The pretest and posttest results show a definite improvement in the children's ability to identify, continue and make up their own patterns. The patterns exhibited in the posttest were much more varied than those in the pretest, indicating the children had an understanding of a variety of types of patterns, not just the geometric patterns they exhibited in the pretest. It is not feasible to say that this improvement is a result of using calculators, because the improvement may have been due to other contributing factors, such as the instruction and types of activities they were subjected to. However, it does not appear that using calculators has had any detrimental affect on children's pattern performance.

The students were also using much larger numbers than they would normally use in mathematics at this year level, with some students having grown quite confident in counting in millions. Other students were also a lot more inquisitive about larger numbers, often asking how to read a number they had put on the calculator display. Thus, even though the study was concerned with increasing students' pattern development it appears to have enhanced other mathematical development as well. The

calculators enabled the students to work at their own level and their own pace, ensuring all students were catered for in the lessons.

The second research question regarded students' attitude towards mathematics and calculators. This study has indicated that the students were definitely enthusiastic towards using calculators, and the calculators became a motivational tool in the lessons. Students demonstrated an increased positive attitude towards both mathematics and calculators after they had been using the calculators for a period of ten weeks. The students appeared to like the choice the calculators gave them in controlling their own learning. It is interesting that some of the students didn't like the fact that the calculators could not be turned off unless you covered the solar panel, so when buying calculators for young children this could be taken into account. More than two thirds of the children believe that it is important for them to be using calculators. It is vital that children value what they are doing in order to enhance their learning, and the children showed that they did value using calculators.

The third area of investigation in the study was the attitude of the classroom teacher to calculators, and how this changed after she had observed her class using calculators for ten weeks. The interviews with the teacher showed a definite change in attitude after observing the calculator lessons. Before the study the teacher had a fairly positive attitude towards the use of calculators, but felt the students definitely had to learn traditional pencil and paper methods before being able to use calculators. However, after the study she was much more enthusiastic towards their

use, and felt it was valuable even for preprimary children to use calculators. The teacher demonstrated a much more open attitude, having developed an awareness of the great variety of uses of calculators with children, a dramatic change from her original attitude that they would only be used for addition and subtraction computations. The classroom teacher also noted the importance of the children having access to calculators during their free time so they could use them in their play for such activities as 'shops' or 'banks'. The teacher also stated that she had learnt things by watching the lessons, thus enhancing her own knowledge of calculators. Another way in which Elaine's attitude changed was that she was less intimidated by calculators. As she had received no training in using calculators Elaine was very unsure of the calculators and appeared to ignore them before the study. However, after observing the lessons and reading information about calculators she was much more enthusiastic to use them.

The final area of investigation for the study concerned parent attitudes to calculators. Based on the data collected in this study it appears the parents are concerned about their children using calculators in year one. The majority of parents believe it is essential that children first learn mathematics using the traditional paper and pencil method, and only after they have mastered this should the issue of using calculators be raised. However, the data also revealed a lack of knowledge on the topic. Many parents were interested in receiving more information about using calculators, and this information may lead to more enthusiastic attitudes

towards the use of calculators with year ones. However, at the moment the parents are tending to show an attitude that using calculators will be detrimental to the children's mathematical development.

Recommendations for further research in this area would include follow up interviews with all children in regard to their questionnaires, to see exactly what they were thinking and why. Interviews with parents would also be very beneficial to understand their background knowledge and beliefs about using calculators with year ones and to see how this changes after getting information about the topic, and actually observing lessons where their children are using calculators in mathematics.

Focussing on areas of mathematics other than patterns, for both pre-primary and year ones, is another area that could be researched in order to provide valuable data about young children, mathematics and calculators.

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PATTERNS

Name _____

Put a tick next to the ones that are patterns



1 2 1 2 1 2 1 2

3 2 8 6 1 0 5 3

9 8 7 6 5 4 3 2

Continue the pattern

5 7 5 7 5 7 _ _ _ _

4 5 6 4 5 6 _ _ _



3 4 5 6 7 _ _

Colour in numbers to make a pattern

1	2	3	4	5	6	7	8	9	10
11	12	13	14	15	16	17	18	19	20
21	22	23	24	25	26	27	28	29	30

Show what this pattern would look like on a calculator



Draw what this pattern would look like with cubes

1 2 3 1 2 3

Make up a pattern of your own

Appendix 2 Student Questionnaire

Name _____

Questionnaire - Students

1. Maths is fun
2. I like maths
3. Calculators make maths fun
4. Maths is easy
5. Maths is easier if a calculator is used
6. It is important that everyone learns how to use a calculator
7. Calculators are only needed when you are older

	Yes	No	Don't know
1			
2			
3			
4			
5			
6			
7			

Classroom Teacher Questionnaire

Background

1. Do you have a calculator at home?
2. Do you use calculators much in your everyday life? How, when, for what reasons?
3. Does anyone else in your house use a calculator? What do they use it for?
4. Have you ever used calculators in your classroom? If yes – how?
5. Have you talked to anyone who has used calculators in the classroom? What were their views?
6. Have you had any information or professional development in using calculators in the classroom? What? What influence did it have on you?

Ideas about calculators

7. How do you feel about the use of calculators with young children? Why?
8. What do you think would be an appropriate age for students to start using calculators? Why?
9. What do you perceive to be the benefits or disadvantages of using calculators with year one students?
10. In what ways do you think calculators could be used in the Year One classroom?

Other views on calculators

11. How do you think the students would view using calculators in class?
12. How do you think the parents would view the use of calculators in mathematics lessons? What gives you that impression?
13. What do you think the other staff members would think about using calculators in class? What makes you think this?

Curriculum and planning

14. Do you believe calculators should be freely available for students to use, or only at specific times? Why?
15. Do you think using calculators for teaching mathematics would make your job easier or harder? Why?
16. Would using calculators require much planning for it to be effective? (e.g. what organization involved? How group students? Should the students or school own the calculators?)
17. Would using calculators in class affect your assessment of the students? If so, how?

Implementing Calculators

18. What would you do if a parent came up to you and said they didn't want their child using calculators?
19. Give an example of a typical lesson you would do using a calculator.
20. How would you react if a child wanted to use a calculator in all maths lessons?

Are there any other comments you would like to make?

Parent Questionnaire

Dear Parents,

The following is a questionnaire about the use of calculators in year one mathematics classes. The results of the questionnaire will be used as part of my research study and it would be much appreciated if you would take the time to fill it in. No names are necessary as it is completely confidential. There is room at the end of the questionnaire for you to add any other comments you would like. There are no "correct" or "incorrect" responses, so I would ask you to answer as honestly as you can.

A = Agree D = Disagree U = Uncertain

If you have any other comments about using calculators in schools or the work the students have done using calculators to learn about patterns please feel free to come and see me before or after school. Any comments would be much appreciated.

Thank you for your time.

Vanessa Thorpe.

Occupation: _____

Age group (please circle): under 25 25-35 36-45 over 45

It is important my child learns mathematics	A	D	U
Comments:			

Calculators are enjoyable and motivating for mathematics	A	D	U
Comments:			

Calculators encourage mental laziness	A	D	U
Comments:			

I think calculators should be used in year one mathematics A D U
Comments:

Calculators shouldn't be used in mathematics until the students are older

Comments:

A D U

My child has learnt a lot since using the calculators A D U
Comments:

Using a calculator gives the students more control over their learning

Comments:

A D U

Calculators should be freely available in the mathematics classroom	A	D	U
Comments:			

The school should provide the calculators rather than the students buying their own

A D U

Comments:

I don't think children should use calculators unless they have mastered the number work with pencil and paper methods

Comments:

A D U

Calculators facilitate the learning of patterns	A	D	U
Comments:			

There may be harmful effects if the children use calculators too much in the classroom

Comments:

A D U

Calculators in school are a bad idea, they will be stolen or they will break, or their batteries will run out

Comments:

A D U

Calculators encourage discovery and investigational work	A	D	U
Comments:			

Since tried and tested methods work calculators are really just
an unnecessary bandwaggon

Comments:

A D U

Are there any additional comments you would like to make?

Adapted from Shuard, H., Walsh, A., Goodwin, J., Worcester, V., Holly, G., & Donaldson, P. (1989). *Using calculators and computers for mathematics in the primary classroom*. SCDC Publications.

Appendix 5 Interview 1 with Classroom Teacher (3/7/97)

- I: Do you have a calculator at home?
- T: Yes I do.
- I: And do you use it much in your everyday life?
- T: Actually I do use it a lot. I use it a lot for paying the bills and working out things, balancing my checkbook and things like that. It's actually in the top draw beside my bed and I do use it.
- I: So would you say you used it often?
- T: Oh, yes...mmm, I might say three times a week. Mostly to do with banking and those sorts of things.
- I: Does anyone else in your house use a calculator?
- T: My son has a calculator. He uses it, actually he uses my calculator to check his homework. He would use it on a regular basis. He's in year six so he uses it to make sure his got all his sums added up correctly.
- I: So that's the only way he'd use it, for checking sums?
- T: No. Actually when we went overseas last year, he used it to work out the exchange rate, when we went to Africa. To make sure the exchange rate was going to be six to one. And we're going to America this year, so I know he'll have it out again to convert how much Australian dollars his got into American dollars. So he would use it for that. He uses it if he wants to work out when he wants to buy something. How much he's got to save each week to get to the total at the end, like when he bought the television. He worked out how much money he needed, and then he worked out how many weeks he had and how much he needed, and then he negotiated his contract for that. So he would use it for practical things like that. I'm just thinking if he uses it for anything else. (Pause). No not really. So that would probably be the most that he would use it. Mostly for his homework. To check his homework.
- I: So have you ever used calculators in your classroom?
- T: Yes, I have actually. When I had a three/four I used to use them as a regular activity. And you're probably going to ask me what activities
- I: Yes.
- T: We used to have a maths book, called "WA Maths" I think it's called, and that had set calculator – I mean obviously the lessons with them were addition, subtraction, multiplication, division – that told them what keys to use. And there were lessons in the book and we used to follow the lessons in the book. But I never actually showed them how to use the memory, because I'm not actually too sure myself.
- I: Right. Have you talked to anyone else who has used calculators in their classroom?
- T: Most teachers in this school would use calculators. Umm, how often I don't know. Pam Smith's in, got the Year 2 class and she was only looking for the calculators last week. So she wanted to use them in year 2, and I know Sandra in the 2/3 uses them and they're kept in Adrian's class, so he would use them. So they're used....because a lot of the maths books that we get now have set calculator activities and the kids are told to get the calculators to do the activities. So Matthew brings home homework sheets and there'll be a section that says use your calculator to do this.
- I: Okay. Have you had any information or professional development in using calculators in the classroom?
- T: No, none whatsoever.
- I: Have you heard of any professional development?
- T: No, actually I haven't. No, not that I can think of. I think I probably, no actually that's probably not true. I did have a – I did get a booklet. Don't ask me where from, but I did get some information, because I don't know how to use all the keys. We didn't have calculators when I was young, and we didn't have calculators when I was in teachers college. So I never actually officially learnt how to use a calculator.
- I: Right. So would you be interested in learning how to use –

- T: Yeah, it would be good. Particularly if I was going back up into higher grades. I think I would have to learn what to do.
- I: So how do you feel about the use of calculators with the young children, like the Year 1's?
- T: Well, obviously they would need to be exposed to it. Umm, when we do our shopping center activities the kids get them out and play with them then, but you have to - at this stage they've just learnt addition and subtraction, some of them still aren't quite sure, so I would feel, that I would do it with concrete materials first. They'd understand what all the symbols mean before you'd use the calculator, to get the answer.
- I: So what do you think would be an appropriate age for students to start?
- T: Oh, probably in Year 1 but it'd have to be definitely in the second half, so I could use, ah, addition and subtraction in this year one class here, haven't done addition and subtraction, so you really couldn't introduce calculators in this classroom until they've learnt that. So I would have to say the second half of the year, third term or fourth term, depending on when the teachers' introduced the concepts.
- I: So what do you perceive to be the benefits or disadvantages of using calculators with year one students?
- T: Well, the benefits. Well, obviously it's technology and they have to know, they use it, the other benefits, benefits...well, I suppose for kids that, you would teach children that didn't know their numbers, they could recognise the numbers on the calculator, you could use it from that point of view. Umm, advantages...I just think it's another way of teaching addition sums, it's a different, another approach to teaching it for some children that maybe haven't cottoned-on to one way, they may understand a different way. Any disadvantages? No, I don't think there would be any, unless you either introduced it to a group of children that didn't understand what they were doing to start with, so they would just be mindlessly copying down answers but they wouldn't really know what it meant.
- I: So, do you feel that calculators could be used in a variety of ways?
- T: Oh, yes I definitely think that they could be used, yes, in a practical way as I said when we have a shop going and the kids will go this is twenty dollars worth of stuff. But you've got to remember year ones really only have to learn up to the number ten. So when we do anything that's got eleven or twelve or thirteen, lots of kids' won't know what eleven or twelve is. Or they'll say how do you write twelve and you say that's a one and a two. So you could only really do addition or subtraction things that go up to ten. Obviously you would extend the ones that can do it. But for the majority, for a lot of them that's as much as they're required to know.
- I: So how do you think the students would view using calculators in class?
- T: Oh, they would love it, 'cause it's something different. It's like anything that you use a different approach in. Something not the normal thing - they would love it.
- I: And do you think that would continue, that they would always enjoy it?
- T: Oh, yes. Yes. Oh, actually, obviously if you did it every single day no they wouldn't, but I think if it was something that was done say once a week, it's like everything - they'd enjoy it. That's like any activity that you do.
- I: What about the parents. Do you think they would have positive or negative views?
- T: Oh, definitely have positive feelings about it. Because parents' always want their kids to learn, so yes, I think parents would feel very happy about it.
- I: And you haven't had any parents asking you about whether you ever use calculators?
- T: Actually I think I did last year, I did have some parents asking me things about it, but it was very early on in the year before I'd actually introduced addition and subtraction. And see you couldn't use the other two keys, multiplication and division, because they don't cover those concepts until year two. But I would explain to the kids obviously what they were, but...no, I've only had the one parent last year asking.
- I: So, how do you think the other staff members would feel about using calculators in year one?
- T: Oh, I don't think they would think anything of it, some of them would obviously think it was silly and be joking about it, but no I don't think, they'd just, well we do everything else, we've got three computers

- in our classroom going now. So I think they would just think, it's just normal and why, I don't know, we weren't using them earlier. 'Cause they probably wouldn't understand when, they have no idea when you actually introduce addition and subtraction, so they wouldn't know, so they would probably think it's normal. I mean I think having so many computers in the room now has changed...calculators, once upon a time it was a novelty to use calculators in the classroom, well now it's not.
- I: Okay, so it's more an integrated part of the classroom now?
- T: Yes. Yes, with all the other activities that you're doing.
- I: Do you believe calculators should be freely available for students to use, or only at specific times?
- T: Umm, I prob – no, I think they could be available for the students to use, we don't have that many in the school. But if we did, and I had, if we all had a box of calculators then I would have them out for the kids to use, yes.
- I: So they'd be able to use them when ever they wanted, or –
- T: Mmm, I'd probably have them in the activities section, so when we are doing activities they could use them then. But if I was able to have a box of calculators in my room, and plus we got into the second half of the year, I probably would use them once a week if they were there.
- I: Do you think using calculators for teaching maths would make your job easier or harder?
- T: Probably easier. It's something else that would motivate them to learn, I think. I don't think it would make it harder. I can't see how it would make it harder. No, I could only say easier there.
- I: Would using calculators require much planning for it to be effective?
- T: Much planning....not at a year one level. I don't think so, because...this will be interesting if you come and tell me you're doing something else. I don't think, after recognising, the kids are where they're at, what's on the actual front of a calculator, doing addition and subtraction....what one did you ask me?
- I: Would there be much planning?
- T: Oh, planning. Well no, I think it would be just like teaching kids to do it on the blackboard, you press the one and it's like writing one, addition, I think it would be the same. If you were teaching middle primary then there would be a lot more planning, 'cause you'd actually have to know all the functions yourself. And I don't. So are you asking this at a year one level?
- I: Yes.
- T: Well, for someone who wasn't familiar with year one, yes, I think they would have to plan out carefully what they're doing, but when you know, you're familiar where year ones are at. You just know by intuition when to move on to the next stage.
- I: Okay, so you don't think there would be too much planning with the actual lessons, about what you're going to teach?
- T: Ohh, oh no. Umm, you'd actually have to have some concrete basis to do it with so they can't just put numbers, sums from the board and copy them. Of course there would have to be planning, but not as much planning as if you were doing it with the middle primary grades. Or upper primary grades.
- I: So would using calculators in your class effect your assessment methods?
- T: Yeah, probably would, yes. So, if you were to look at, umm, a report, I would probably, we only get number – there's only one box for number, and so no I would just, I suppose I would just put it in with all my other calculations that I do, whether it's a concrete activity or whether it's an observation, what they've done, or whether it's a sum...I suppose I would put it in there, it probably could come in under problem solving, see I haven't assessed the kids in problem solving, this time. So I could look at it from that point of view.
- I: So you would assess it from both practical aspects –
- T: as well –
- I: watching them?
- T: yeah, as well. And I would just make a note of children, it's like children that have trouble with computer and there are some kids that catch on very easily. And I'm sure if you did an activity and the kids had to use a calculator to solve it, the brighter ones would immediately, they would make up

other sums, I could see that happening. So yes, it would just fit in with everything else. There'd just be another problem for them, to assess.

I: Okay, what would you do if a parent came up to you and said they didn't want their child using calculators?

T: I'd probably ask them why. And find out specifically. I recently had a parent who didn't want me to use have-a-go pads, so I just listened to her reasons why she didn't like it, then I gave my reasons why we were going to use it. And I convinced her that it was right. So I would probably ask for her reasons, well his or her reasons, I should say, and then I would explain my viewpoint, and say well, we're doing it! That's that! I would probably welcome them into the classroom, to see how I'm going to use them, and then after the lesson find out if they still feel the same.

I: Right. Can you give me an example of a typical lesson you would do using a calculator?

T: It would probably be something very concrete, umm, I have used it in the past with the shopping centre. I suppose just, mmm, I'd have to think about that, how it would be. I suppose I'd have some kind of a written worksheet that related to practical things we were adding up. I would have done it with the class as a whole, just like when you're doing addition sums. Actually, I really would have to have a big calculator, as well, I think. I'd say, well press this and press this and then you press this.

I: So when you used them in your shopping centres was that very directing or was it just free play.

T: No, it wasn't directing, it was more or less free play, but the ones who wanted to know how it worked, I showed them. The ones who didn't, I didn't.

I: So how would you react if a child wanted to use the calculator in all of the maths lessons, not just the specific ones you had planned?

T: Oh, I wouldn't let them.

I: So what would you say to the child?

T: Oh, I'd probably say, well, umm, I would probably even check...their answers, no I wouldn't let them use them in every single lesson. I might say, yes, well if you've finished early then you can use a calculator to check, but if there was a strong desire from a lot of children to use calculators, then I, perhaps once a week, but I still think there are other activities in maths that we have to cover. That you couldn't use the calculator for.

I: So are there any other comments you would like to make about calculators?

T: Oh, well I'm looking forward to seeing what you're going to do. Maybe give me some ideas, maybe to give me a different perspective than what I have at the moment. As I said, I haven't used them a great deal in year one.

Appendix 6 Interview 2 with Classroom Teacher (8/9/97)

- I: Have you found that you are using your calculator at home any more or less than before the study started?
- T: To be honest, no – I'm using it the same. Exactly the same.
- I: Okay. So when you are using your calculator the reasons for using it haven't changed at all? You're using it for the same sorts of things?
- T: Yeah, the same sorts of things. Working out, you know, how to balance my checkbook, and at the moment, because we're going to America on Saturday I've been working out exchange rates. But no, not really – I haven't changed at home, no.
- I: Have you received much new information about using calculators in year one since I started the study?
- T: Oh, most definitely. Some of the books that you lent me, I copied work out of that. And I can see when the children are working, I mean, you were doing activities that I wasn't even aware of. So yes, I have got a lot of new information and I can see the possibilities in the classroom now.
- I: Great. So do you think this has changed your view at all?
- T: Oh, definitely. Definitely changed my views. I can see even just using it at the beginning of the year just recognising the numbers, on the calculator, would be an extra activity for the kids to use, to learn... their numbers.
- I: So how do you feel about the use of calculators with young children?
- T: Oh, umm, I wasn't against it before but maybe I didn't think you could use it until the kids had learnt, like, their addition and subtraction sums. But now I can see that there are lots more possibilities than I was aware of. And I can also see that having them in the classroom has been good in activity time. Because the children get them out and use them and set up shops and they've been making money. So they use them in their, umm, informal play as well.
- I: What do you think would be an appropriate age for students to start using calculators?
- T: Well, now I could even say back in pre-primary, because I imagine in pre-primary they would use them as well. Just having seen what my year ones can do. I mean there would be the novelty to start with. But then I actually see them making them and pressing things. Yes, I think pre-primary would – or even younger, I suppose, if parents had them at home. But in the school environment, pre-primary.
- I: Right. What do you perceive to be the benefits or disadvantages of using calculators with year ones?
- T: I don't actually see disadvantages. So it would only have to be benefits. Just the fact that it would be another...piece of equipment that you could use to teach children, umm, things that you are already doing. And also, like the activities that you were doing, where they're doing multiples of twos and threes. They've got a chance to write numbers of much higher, umm, level. Much higher numbers than they normally could use, because they can copy them from the calculator, they were writing down 680 and 682, things like that, which they normally wouldn't be able to do.
- I: So, in what ways do you think calculators could be used in a year one classroom?
- T: Well, I would definitely, as I said earlier, use them to do with just recognising the numbers to start with. Umm, free play. I would use them ... like you were doing with the patterning work, making patterns on the calculator, and then also, umm, what you were doing with counting in 2s and 3s – everything that you've done, I would repeat now next year. I mean we were learning counting in 2s and counting in 5s, and we were doing groups of them together, but I had never considered using the calculator, but it just fitted in so well.
- I: Good. How do you think the students felt about using calculators in class?
- T: Oh, they really enjoyed it, it was very motivating for them, they just loved it.
- I: Right. So what made you think this?

- T: Because it's something new and something different and perhaps it's something they see only adults using, and it's like using the computer. Probably more so, more exciting than using the computer because they've all got access to the computer but we haven't had calculators in the room.
- I: So do you think their enjoyment would continue over the year?
- T: I think so, yeah, I think so.
- I: Do you think the parents have positive or negative views about their children using calculators in maths?
- T: They haven't spoken to me since initially when we filled out the permission slip, and two of them had concerns that they were just going to use the calculators to solve sums. That they weren't going to learn $1 + 1$ is 2, they would use the calculator. Which I couldn't quite understand, but that was what their concerns were. And they haven't actually mentioned it to me since. So, I really don't know what they think.
- I: Okay. Have you had any parents approaching you – oh well, you just said –
- T: No I haven't, no, none of them. They approached me with the permission slip, but since you've started, no, they haven't. Said anything at all.
- I: Okay. When they first approached you with their concerns, did that affect your opinion at all?
- T: Oh no, I, umm, got out the lesson plans or the activities that you had outlined, and said well this is what they will be doing and explained. And once I explained the sorts of activities that you were going to do they were fine.
- I: What do you think the other staff members would think about using calculators in year one?
- T: Umm, I suppose they would think that if I had a place for it that would be okay to use it. I don't think they would be against it, and say well you can't use it in year one. They probably wouldn't be aware of what I was doing with them. But, no, I think they would be okay about it, that would be fine.
- I: Do you believe calculators should be freely available for students to use, or only at specific times?
- T: Well, having you had them in the room, now, this has been the eighth week, we've had them there, freely available. The children have used them when you've come in, and they've used them in activity time – not all the time. And not everybody. To start with the boys had them and they were playing with them and they were like keypads in their activities they were playing, it wasn't maths related, they were just playing with them. Umm, I've noticed then another little group started up doing shops. So, I don't think – I think it's okay just to have them all the time, because they use them. If I said, okay we'll have calculators during activity time, they would have had the same access if the fact that they're there all the time. So I don't think it makes any difference, I think they should just be there all the time.
- I: Do you think using calculators for teaching mathematics would make your job easier or harder?
- T: Well actually I think it probably makes it easier, it's another way of explaining something to them. And with the patterning work that was really good. Yeah, I just think it makes it easier.
- I: Would using calculators require much planning for it to be effective?
- T: Yes, I think it would, having seen the books that you gave me and had a look at the activities that are in there. Yes, it would be. Otherwise you just stick to the same things that you know about, like I just thought you would use it for adding and subtraction. You'd be limited, so you really need to plan out what you're going to do, and have a look and go back to your books and just check.
- I: Would using calculators in class affect your assessment of the students?
- T: I don't know, I'd have to think about that. Umm, yes I suppose you could use it as a form of assessment. Like when I test the kids at the beginning of the year can they recognise their numbers, it would be really easy 'cos it's a one to one. They could come out and press the number on the calculator, you could do that. Yes, there's no reason it couldn't form part of your assessment.
- I: Right. And do you think actually assessing their work when they're using calculators would be difficult?
- T: Oh, no – it would be more informal, it would just be more or less walking around, the same as a lot of assessment you do in year one anyway. Just walking around the room and looking over their shoulder as they're doing it, and then, you know, making anecdotal records as you're going along.

- I: So what would you do if a parent came up to you and said they didn't want their child using calculators?
- T: Probably the same as I did when the parents came to me, the two that came to me, and explain the sorts of activities. Umm...and say, well this is what we're doing. I would try to address their concerns, like, all the other concerns that they have. Say well, this is the way we're doing it, which hopefully they would be happy about it afterwards. After I've explained why we're doing it and what we're doing. Most parents usually are when you do that.
- I: Can you give me an example of a typical lesson you would do using calculators?
- T: Well some of the ones that I've run through earlier, all of the lessons that you have done while you have been here I certainly would use, and also the one as I said, identifying the numbers, I think that would be a good activity. But, um, there were more activities, I just browsed through the books you gave me, and photocopied some of the activities. So, yes, I would um coping the ones that you did would give me something to start with, and I'm sure once I got involved in it other ideas would spring to mind.
- I: How would you react if a child wanted to use a calculator in all of the maths lessons, not just the specific ones you had planned?
- T: Um, I guess it would depend on what the activity was. Because not all lessons are number based ones, it could be a space or measurement. But, if we were just doing straight sums and they wanted to use it, well I would suggest they did it to check their work afterwards. And then say to them, well next time we'll do a lesson where we'll just use the calculators to work out the answer, we won't use blocks or in our head. It would just really depend on the activity and who the child was at the time.
- I: Are there any other comments you would like to make about calculators?
- T: Well it's been great. It opened my eyes, you get so narrowed in with what you're doing that you're not aware of, sometimes, all the possibilities. So, no, for me it's been really beneficial, and for the children. So thank you.
- I: I'm glad you're happy with it.
- T: I'm very happy with it.

Appendix 7 Children's Responses to the Question: 'What do you Know About Calculators?'

Before Study

- 'Calculators count numbers'
- 'You can do pluses on them'
- 'The last number comes first'
- 'You can put your phone number on them'
- 'You use them when you get older'
- 'They give you freckles'
- 'You can put money on it' (he explained he had seen his mother work out shopping prices using a calculator)
- 'You can play games on them'
- 'You can make numbers with them'
- 'They make things easier'
- 'They give you information around the world'
- 'To work out prices'
- 'They only bring up numbers'
- 'They help you learn to write numbers'

After Study

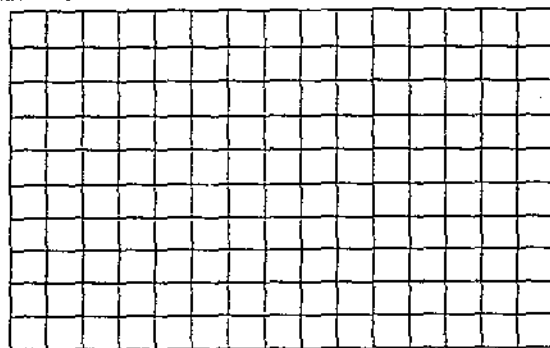
- 'Calculators can work out prices'
- 'You can put numbers on a calculator'
- 'You shouldn't use them all the time' (This girl explained her mother had told her this)
- 'You can make patterns on calculators'
- 'Calculators help you count'
- 'You can do adding and subtracting'
- 'I don't know what its called, but the (drawing a square root symbol in the air) key changes the number'
- 'You can put phone numbers on them'
- 'You can write words on a calculator'
- 'Calculators have numbers on them'
- 'Clearing makes numbers come up'
- 'You can copy numbers off them'
- 'You can save on a calculator'
- 'Colours appear on the screen when you press the sides'
- 'You can make pictures, like glasses'
- 'You can use them in school'

Name _____

Patterns

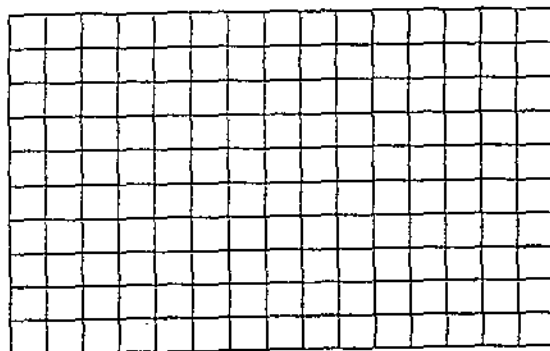
Pattern 1

With cubes it looks like this



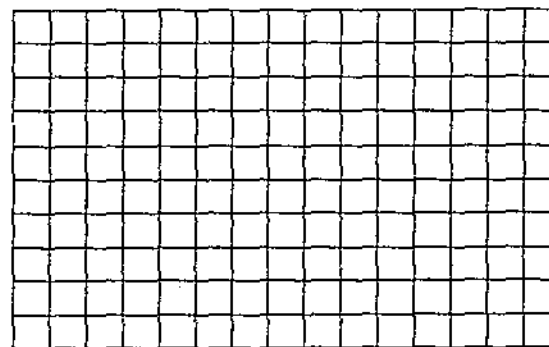
Pattern 2

With cubes it looks like this



Pattern 3

With cubes it looks like this



My pattern

My partner's pattern



32323232

11001100

55755755

82828282

69696969

33443344

80808080

Can you copy these?



5875

7397

9949

2002

939

3153

585

Can you complete these?



Name _____

Growing Patterns

The pattern is

I would need _____ cubes to make this pattern.

What the pattern looks like with cubes.



Another growing pattern is

Appendix 11 Using the Calculator to Count by Numbers

Stuart: Counted in 5s up to 240.

Phoebe: Counted in 3s up to 129, then pattern got mixed up.

Andrew: Counted by 4s up to 52. Andrew wrote his numbers so they looked like the numbers on the calculator.

Susan: Two patterns. Started counting in 3s, then started a new pattern counting by 5s.

Derek: Counted by 5s to 240.

Alison: counted by 10s to 900.

Ned: Counted in 1s to 57.

Kate: Counted in 1s to 65

Peter: Counted by 10s to 250, then changed to counting by 100s.

Mark: Counted by 5s to 65.

David: Counted by 9000s to 1 350 000.

Rebecca: Counted by 3s to 153.

Grace: Counted by 3s to 114.

Joshua: Counted by 9 000 000s to 99 000 000, then started a new pattern counting by 5s.

Paul: Counted by 9 000s up to 279 000.

Michelle: Counted by 50s up to 1 850.

Clare: Counted by 3s to 153.

Brooke: Counted by 3s to 75.

Amanda: Counted by 10s to 390. Started new pattern counting by 9s.

Joanne: Counted by 5s to 205.

Emily: Counted by 5s up to 295.

James: Continued same pattern as last week counting in 9s up to 1287.

Appendix 12 Children's Work Samples: Growing Patterns

1	2	3	4	5	6	7	8	9	10
11	12	13	14	15	16	17	18	19	20
21	22	23	24	25	26	27	28	29	30
31	32	33	34	35	36	37	38	39	40
41	42	43	44	45	46	47	48	49	50
51	52	53	54	55	56	57	58	59	60
61	62	63	64	65	66	67	68	69	70
71	72	73	74	75	76	77	78	79	80
81	82	83	84	85	86	87	88	89	90
91	92	93	94	95	96	97	98	99	100

1	2	3	4	5		7	8	9	10
11		13	14	15	16	17		19	20
21	22	23		25	26	27	28	29	
31	32	33	34	35		37	38	39	40
41		43	44	45	46	47		49	50
51	52	53		55	56	57	58	59	
61	62	63	64	65		67	68	69	70
71		73	74	75	76	77		79	80
81	82	83		85	86	87	88	89	
91	92	93	94	95		97	98	99	100

Appendix 13 Children's Writing Samples

We have calculators in
our classroom.
and the calculators have
lots of buttons and
they are fun. we
play with them. We
play with

Cal Calcul Calculators
are good for maths
I use them a lot
they are useful

when you press
a button. and
this is the
button I mean
☒ you can
put numbers
on a calculator.